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Stuart G. Hibben

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13. ABSTRACT

This report includes abstracts and bibliographic lists on contractual subjects that were completed in April 1973. The major topics are laser technology, effects of strong explosions, geosciences, particle beams and material sciences. A section on atmospheric physics and one on miscellaneous interest is also included.

Laser coverage is generally limited to high power effects. All current laser material is routinely entered in the quarterly laser bibliographies.

An index identifying source abbreviations and a first-author index to the abstracts are appended.

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INTRODUCTION

This report includes abstracts and bibliographic lists on contractual subjects that were completed in April, 1973. The major topics are: laser technology, effects of strong explosions, geosciences, particle beams, and material sciences. A section on atmospheric physics and one on itesm of miscellaneous interest are included as optional topics.

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TABLE OF CONTENTS

1. Laser Technology

A. Abstracts

Rykalin, N. N., A. A. Uglov, and A. N Kokora. Effect of laser irradiation of iron alloys. FiKhOM, no. 6, 1972, 14-21.

Laser beam interactions with ferrous alloys are discussed in connection with industrial applications of lasers, such as hole drilling in structural carbon steel. Consecutive stages of laser beam destruction of opaque materials are reviewed. Singularities, and an initial shift in critical points A_c and A_r from heating and cooling which occur in steels heated by laser beams, are evaluated at power densities below the critical value q*, typically at $q = 0.9 \times 10^5$ w/cm^2. Numerical values of the heating rate $dt/d\tau$, where τ is the pulse duration, are calculated for type ShKh-15 steel at different points in a given volume of the material. The calculated plots of $dt/d\tau$ versus the distance r from the center of a heating spot (Fig. 1)

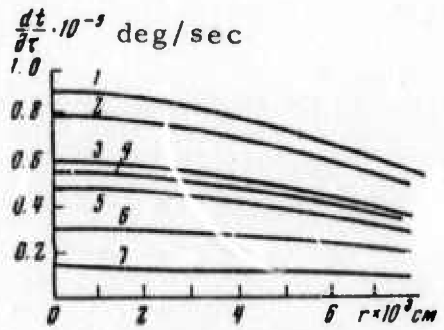

Fig. 1. Heating rate of ShKh-15 steel by 0.5×10^{-3} sec. laser pulses versus r at various depths z($q = 0.9 \times 10^5$ w/cm^2, mean convergence $k = 80$ cm^{-2} in the normal distribution law of f(r): 1 - 3×10^{-3}, 2 - 2×10^{-3}, 3 - 10^{-3}, 4 - 5×10^{-3}, 5 - 0, 6 - 6×10^{-3} and 7 - 7×10^{-3} cm.

show that the $dt/d\tau$ maximum at a given r is located at $z_{max} = 0.424\sqrt{\tau}$. The heating rate in the region affected by the beam and in those regions where the temperature rises above the point Ac_1 of $\alpha \rightarrow \gamma$ conversion, was

calculated and found to vary in the $0.9 \times 10^5 - 0.18 \times 10^5$ deg/sec range as [illegible] increases from 4×10^{-3} to 7×10^{-3} cm. The shift of A_{C1} at $dt/d\tau = 0.5 \times 10^5$ deg/sec. was consequently calculated to be $t_x = 200^\circ$ C.

The effects of free-running and quasistationary laser pulses differed with respect to configuration of the fused zone. The quasistationary pulse pressure on the melt center generated capillary waves which appeared after crystallization as rings on the periphery, but not the center, of the solidified zone. Calculations confirmed this capillary wave distribution. In contrast, capillary waves were absent in metal irradiated by a free-running laser with spikes. Changes in C and alloying element contents, and the abnormally high microhardness of the metal in the region affected by the laser pulses, are analyzed as specific laser effects. The observed laser beam strengthening of ferrous alloys is interpreted as the combined effect of crystal structure defects, dislocations, vacancies, and martensitic conversion. This interpretation is supported by an x-ray diffraction analysis of the substructure of various ferrous alloys and by electron micrographs of carbonyl iron foil, which show an increase in dislocation density after exposure to a free-running pulsed laser. A qualitative analysis reveals that the laser beam threshold power density must be lower for ferrous alloys with a higher C content. The alloying elements are also redistributed in the region affected by the beam. These qualitative findings have been confirmed by experimental distribution curves of C and Cr in Kh12M steel, in the region affected by an 1.8 msec pulse from a free-running Nd glass laser.

Fersman, I. A., and L. D. Khazov. Surface damage mechanism of a transparent dielectric irradiated by a short optical pulse. Kvantovaya elektronika no. 4 (10), 1972, 25-31.

Experimental data on laser-induced surface damage in transparent dielectrics are given in support of an electron-thermal mechanism of destruction. The emission was recorded of $10^{12} cm^{-2}$ or $5 a/cm^2$ positive ions from K8 glass irradiated by $3 x 10^{-8}$ sec. pulses from a ruby laser at a power density w half that of the optical discharge threshold. An ionic emission was also recorded from a sapphire surface, with an intensity more dependent on surface treatment than the nature of the material (Fig. 1).

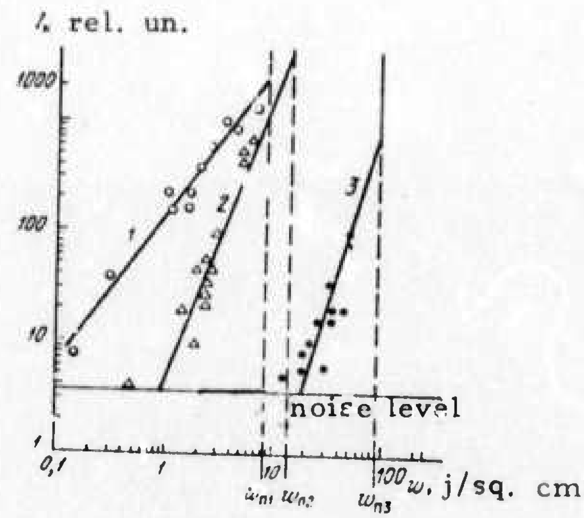

Fig. 1. Photocurrent I of the initial flash versus w of a ruby laser beam (τ = 30nsec): 1 - ground K-8 glass, 2 - polished sapphire, 3 - polished K-8 glass.

The observed emission indicated the presence of conduction electrons whose concentration was evaluated theoretically, for example, $N_v = 1.2 \times 10^{19} cm^{-3}$ for sapphire at m. p. Experimental results show that the optical discharge (spark) threshold w_{thr} is independent of the surface temperature of K-8 glass within ~100 to 800° K, or sapphire within from 300 to 1060° K. The W_{thr}, in contrast, was highly dependent on surface treatment (Table 1) and on the laser emission wavelength (Fig. 2).

Table 1. Optical strength of differently treated surfaces.

Material	Thickness of residual cracked layer, μ	W_{thr} at $\lambda = 0.7\,\mu$, relative units
Sapphire	5 (ground)	0.47
	2	1
	1-2	1.7
	0.03	2.5
	completely removed	4
K-8 glass	6-10 (ground)	0.2
	30-2	1
	3	2
	completely removed	5

The latter dependence interferes with the determination of the spectral characteristic of the internal photoeffect, which is the basis of the surface destruction mechanism. Tabulated data (Table 1) confirmed the conclusion, based on the electron thermal destruction mechanism, that the surface optical strength can be increased by improving the surface treatment.

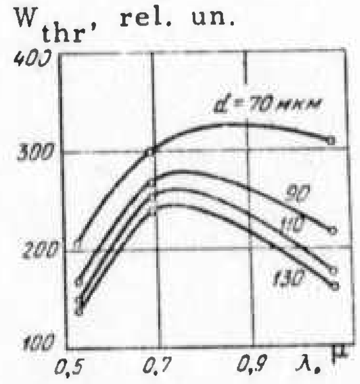

Fig. 2. Spark threshold vs. laser emission wavelength at varying d of the irradiated surface area. The specimen is polished, ultrapure fused quartz, (λ = 0.16 μ).

A strong anisotropy of optical strength was detected in carefully polished and etched calcite. This also confirms the assumed role of the internal photoeffect as the origin of destruction. Under the same surface treatment conditions, most glasses exhibited similar optical strength in agreement with the electron-thermal theory. The only exception was type TF5 heavy flint glass with a much lower optical strength. The authors conclude that their experimental data combined with previous observations support the electron-thermal hypothesis of destruction of transparent dielectric materials by short optical pulses.

Arifov, U. A., T. U. Arifov, and D. D. Gruich. Generation of multicharged metal ion beams using giant pulses from a ruby laser. IAN Uzb, Seriya fiz-mat. nauk, no. 6, 1972, 43-48.

An apparatus is described developed for generating and recording multicharged metal ions by irradiating a metal target with giant

laser pulses. The multicharged ions are used to produce transuranium elements in accelerators, and to study their interactions with solid surfaces. The apparatus (Fig. 1) consists of a Q-switched ruby laser and a mass

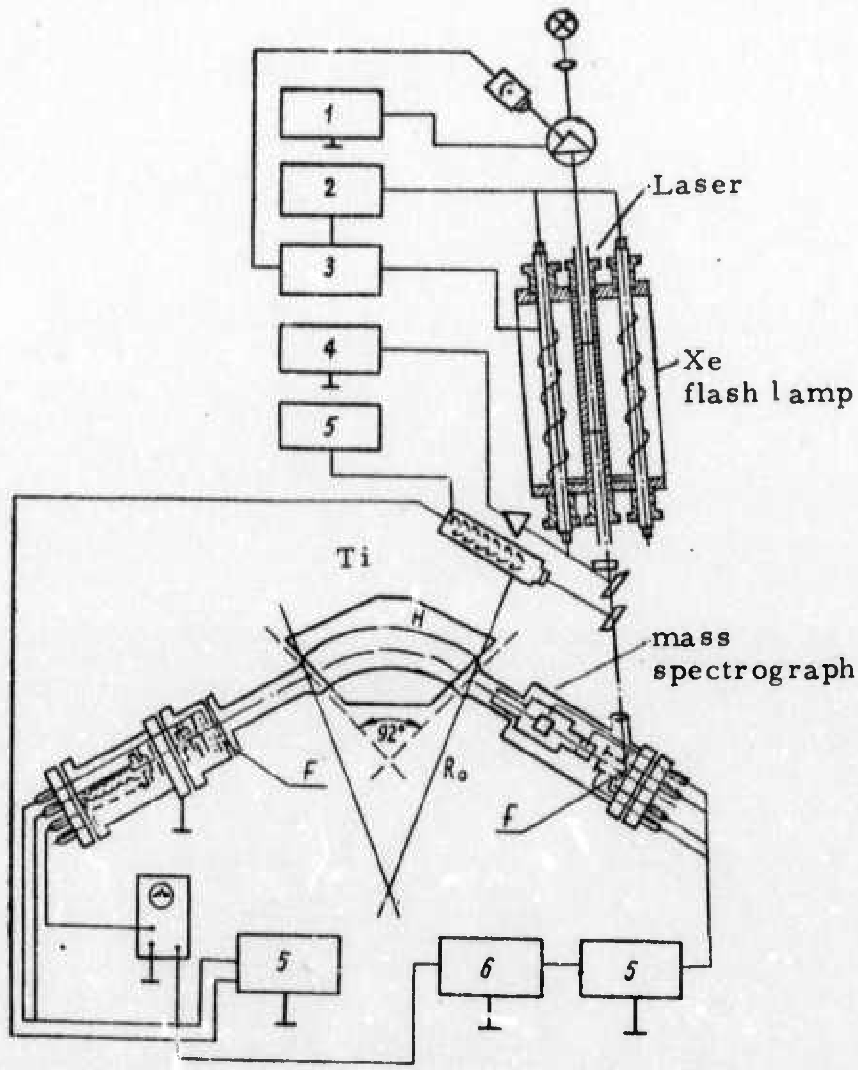

Fig. 1. Experimental assembly for generating and identifying multicharged ions: 1 - audio-frequency oscillator, 2 - power pack for flash lamps, 3 - flash control circuit, 4 - power meter, 5 - stabilized high-voltage rectifier, 6 - sawtooth pulse generator.

spectrograph which analyzes short pulsed ion beams. The ruby was pumped by xenon flash lamps. Q-switching was obtained by rotation of a totally-reflecting prism. To extract the highly charged ions, 1.2 j laser pulses of 50 nsec duration were used. The emitted pulse was focused on a titanium target at a 55^{o} incidence angle to a spot of ~1mm dia.; incident power density was about $3x10^{7}$ w/cm^{2}. Power and duration of laser emission were measured calorimetrically with a ± 10% maximum relative error. In addition to the Ti target in the mass-spectrographic chamber, the ion source included a Wehnelt cylinder, the extraction electrode serving as the entrance slit, and an electrostatic lens. Resolution power of the mass spectrograph was~500, and the chamber aperture angle was 60^{o}.

Oscilloscope traces of the ion and electron beams emitted by the Ti target show significant intensity ~300 µsec after the laser pulse cut-off. Duration of the sawtooth voltage pulse, which modulated the ion acceleration, was consequently determined to be~50µsec. A narrow mass-spectral region with two Ti^{8+} peak pulses of ~50 µsec duration was observed. The position of peak pulses of specific ions was measured from the maximum intensity ion beams produced by a stepwise increase in magnetic field intensity. The mass spectra of Ti ions show peaks corresponding to Ti^{1+} - Ti^{8+}. Detection and separation of Ti ions with charges >8 was difficult because of the wide spread in ion energy. At a recording sensitivity ~10^{-13} a/mm, Ti ion beam intensity at the reception point varied from 10^{-8} to 10^{-10} a/mm. Ions with higher charges could be generated by increasing laser power and shortening laser pulse duration.

Gryaznov, I. M., A. A. Kovalev, L. I. Mirkin, and P. I. Ulyakov. Study of melt zone and thermal effect in metals from laser beams of varying duration. FiKhOM, no. 5, 1972, 8-10.

The structure was studied of iron, steel, and aluminum alloys subjected to laser beams with a pulse duration varying from 0.5 to 12 msec and power densities $\cong 10^7$ w/cm^2. Solidified melt zone dimensions and the thermal effects were evaluated metallographically. At $\lambda = 1.06\ \mu$, a pulse with a total duration of 1.7 msec was interrupted by a high-speed explosive shutter, synchronized with a time-variable delay line, to vary the beam duration from 0.5 to 1.7 msec. A special LC line switched into the discharge circuit of the pump tube was used to generate a 12 msec pulse. Increasing the pulse duration resulted in crater contraction, an increase in the liquid phase level remaining in the crater, and an increas in the thermal-effect zone dimensions. It is shown that liquid phase flow along the crater walls is lamirar, and that the role played by condensation from the gas phase is negligible. Tabular data are given of laser pulse parameters vs. crater geometry.

Alekseyev, V. A., S. D. Zakharov, P. G. Kryukov, and Yu. V. Senatskiy. Feasibility of using a dense plasma jet as a target in studies of laser heating. KSpF, no. 7, 1972.

Experimental determination of the electron density distribution n(x) in the surface plasma layer of a laser-heated solid target has not yet been achieved, because of extremely high n values and short lifetime (10^{-9} - 10^{-10} sec) of a dense laser plasma. Since n(x) determination is essential for research on laser CTR, the authors propose instead to substitute a low-temperature dense plasma jet for the solid targets commonly used in experimental plasma heating by laser. Measurement of n in a plasma

jet would be inherently easier because jet discharge velocity is much lower than plasma dispersion. Since the n(x) level could be held constant during heating by short (10^{-11} sec) laser pulses, a study of heating at different n(x) would become possible.

The use of a generator introduced by Alekseyev is proposed to generate a low-temperature plasma jet in which the material is in a supercritical state. The resulting plasma jet offers the possibility of studying absorption and reflection of high-power laser radiation by a hot plasma, optimizing the initial target parameters for laser-induced nuclear fusion, and laser diagnostics of the supercritical state. In the generator described, (Fig. 1) discharge of a capacitor bank through the target

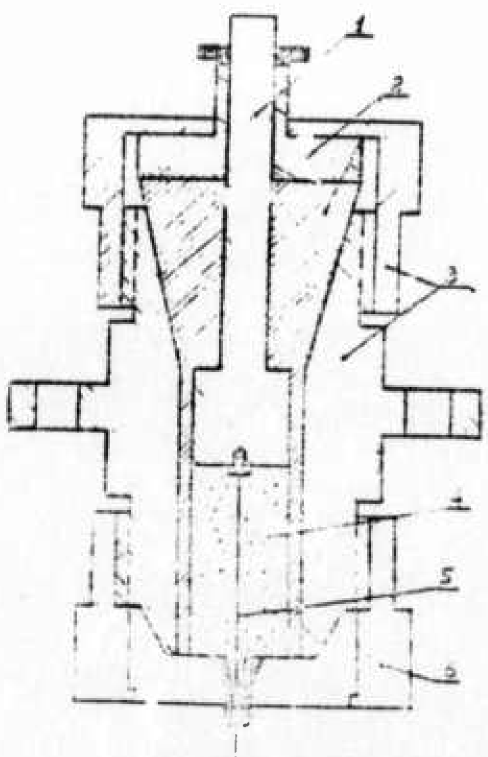

Fig. 1. Low-temperature plasma jet generator. 1 - upper electrode, 2 - insulation, 3 - generator casing, 4 - dielectric, 5 - copper wire, 6 - lower electrode.

material (dielectric) generates sufficient energy to force a dense jet of material through a Laval nozzle during time intervals up to 1 msec. Average jet temperature and jet discharge velocity have been measured at about 7,000° and 10^6 cm/sec, respectively. The high density of discharge material was confirmed by the experimentally established temporary (for~0.5 msec) opacity of the jet to the red beam of a He-Ne laser. The generator described could, with a simple modification, produce a quasicontinuous jet with annular cross-section for studies of laser plasma cumulation.

Kaliski, S. <u>Explosion cumulation of a plane electromagnetic field at relativistic initial velocities of a conductive shell.</u> Bull. Acad. pol. sci., ser. sci. techn., v. 20, no. 2, 1972, 119-125. (RZhF, 8/72, no. 8A242)

In connection with plasma heating by lasers, a solution is presented to the problem of contraction of a plane magnetic field from implosion of a heavy conductive shell, moving through the field at a given initial velocity v. Assuming v is quasirelativistic, the problem is formulated by equations of electric and magnetic field components and shell motion with boundary and initial conditions. The E and H fields obey Maxwell equations and the boundary conditions are in the form of ordinary differential equations. A solution for the equations is obtained by the method of characteristics (Fig. 1). Assuming v is constant in the t_{i+1}, t_i sections, H on the plate surface is given by

$$H_i^* = H(t_i) = F(ct_i + x_{0i}) + F(ct_i - x_{0i}) \tag{1}$$

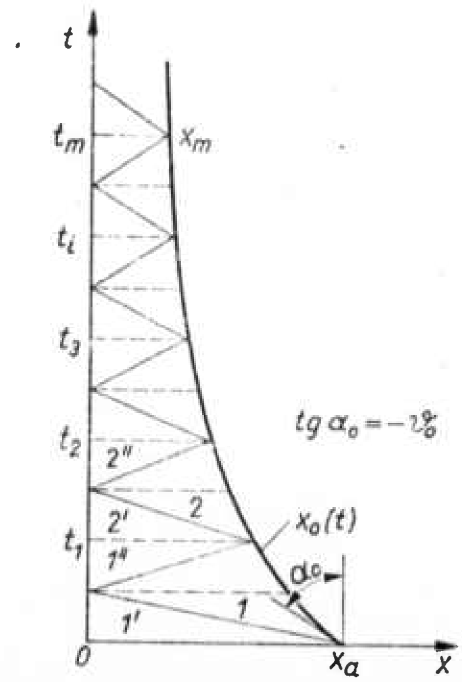

Fig. 1. Solution plots in the plane of characteristics

The relation between H* and the function F for successive sections of the solution is

$$F(\kappa)+F(\kappa)\frac{1+v_{j+1}}{1-v_{j+1}}=F(\kappa)\frac{2}{1-v_j}=H^*(\kappa) \tag{2}$$

where

$$c\tau+x_0(\tau)=\kappa, \tag{3}$$

and $F_{j+1} = F$.

Solution of the equation of shell motion in a non-relativistic approximation is given as

$$v = \sqrt{v_0^2 - \frac{H_0^2 x_a^2}{4\pi m} \frac{1}{x_0}} = \dot{x}_0 \tag{4},$$

where

$$H = H_0 \frac{X_a}{X_o}$$

and m is the mass of the wall unit surface. Practical values would be $v \approx 10^9$ cm/sec, $H_o = 10^5$ gs, and $m \approx 1 g/cm^2$. A closed solution to the problem of magnetic field contraction was obtained based on the quasi-relativistic approximation. When $v/c \leq 1$, the field discontinuity of the characteristics can be disregarded and solution (4) is applicable, in agreement with the known non-relativistic (quasi-static) solution of field constriction by implosion. The quasi-relativistic solution may be applicable for very high implosion velocities, particularly in cumulative laser heating of plasma.

V. P. Silin. <u>Relaxation processes in a parametrically unstable plasma.</u> ZhETF, v. 63, no. 5, 1972, 1686-1697.

Several theoretical aspects of relaxation of ion distributions in a parametrically unstable plasma are analyzed. The possibility of appearance of fast ions, related to Cerenkov interaction of particles with the oscillation of the potential field in plasma, is considered first. The qualitative features of the relaxation process are established for a steady-state field fluctuation, which indicate that in a parametrically unstable plasma a significant number of fast ions will appear with energy $(m_i/m_e)^{1/3}$ times

greater than the energy of oscillating electrons in the field of pumping wave (m indicates electron and ion mass). An analogous possibility is analyzed for the case when the level of field fluctuations in a parametrically unstable plasma increases. Under the assumption that distribution variation is slow, it is shown in the resonance case that the mean energy of plasma ions grows by a factor of $(m_i/m_e)^{1/3}$ times the energy density of the field fluctuation.

In the non-resonance case of radiation parametric interaction, it is shown that the mean ion energy is on the same order as the energy of the field fluctuations. The relaxation of electron distribution under the condition of growing fluctuations in parametrically unstable plasma is also analyzed. It is shown that high frequency harmonics of the electron velocity distribution are produced, and that electron energy spread is determined by the energy of plasma fluctuations density referenced to one electron. The reasons for the anisotropy of particle velocity distribution are investigated.

B. Recent Selections

1. Beam Target Effects

Anisimov, S. I., and A. Kh. Rakhmatulina. Dynamics of vapor expansion from evaporation in vacuo. ZhETF, v. 64, no. 3, 1973, 869-876.

Batanov, V. A., V. A. Bogatyrev, N. K. Sukhodrev, and V. B Fedorov. Spectral diagnostics of a plasma flare, generated by vapor products from laser-irradiated metals. ZhETF, v. 64, no. 3, 1973, 825-832.

Batanov, V. A., and V. B. Fedorov. Liquid phase flushing - a new mechanism of crater formation during vaporization rise in a laser-irradiated metal target. ZhETF P, v. 17, no. 7, 1973, 348-351.

Belyayev, L. M., V. V. Nabatov, V. N. Rozhanskiy, N. L. Sizova, and A. A. Urusovskaya. Damage mechanism to the surface of a CsI crystal by a focused laser beam. Kristal, no 2, 1973, 334-338.

Bonch-Bruyevich, A. M., Ye. I. Balashov, A. I. Gagarin, A. S. Zakharov, V. N. Kotylev, and O. I. Kalabushkin. Experimental study of shielding by aluminum vapors. ZhETF P, v. 17, no. 7, 1973, 341-344.

Hasse, R., A. Knecht, and N. Neuroth. Damage to optical glass by giant laser pulses. Part II. Internal glass damage by a converging beam. Schott - Inform., no. 2, 1972, 8-14. (RZhF, 1/73, no. 1Ye292)

Papirov, I. I., S. S. Avotin, E. P. Krivchikova, and L. A. Korniyenko. Deformation of beryllium single crystals by laser irradiation. FiKhOM, no. 2, 1973, 147-148.

Raychenko, A. I. Heat propagation in a solid from the action of a short thermal pulse. FiKhOM, no. 2, 1973, 137-141.

Uglov, A. A. Material from seminar on physics and chemistry of material processing by concentrated energy fluxes (Baykov Institute, Moscow, June 22-23, 1972). FiKhOM, no. 2, 1973, 157-159.

Veyko, V. P., G. A. Kotov, and M. N. Libenson. Thermal action of laser radiation on various polymers. FiKhOM, no. 2, 1973, 16-18.

Zakharov, V. P., and V. I. Zaliva. Change in specific conductivity of germanium chalcogenide amorphous thin films under pulsed heating. FiKhOM, no. 2, 1973, 141-142.

ii. Laser-Plasma Interaction

Gernitts, E., V. Ye. Mitsuk, and V. A. Chernikov. Study of laser radiation absorption in a laser spark in air. ZhTF, no. 3, 1973, 563-569.

Kaliski, S. Concentric uniform elastic spherical wave excited by thermal explosion of the envelope. Bulletin de l'Academie Polonaise des Sciences, serie des sciences techniques, v. 21, no. 2, 1973, 33(75)-38(80).

Karlov, N. V., N. A. Karpov, Yu. N. Petrov, and O. M. Stel'makh. Self-focusing of CO_2 laser emission in resonance absorptive gases. ZhETF P, v. 17, no. 7, 1973, 337-340.

Mennicke, H. Observation of stimulated anti-Stokes harmonics of a high Raman scattering order, and their role in the initial stage of laser plasma formation. IPP-Berichte, no. IV/40, 1972, 51S. (RZhF, 2/73, no. 2G188)

Pustovalov, V. V., V. P. Silin, and V. T. Tikhonchuk. A quasilinear theory of parametric instability of a magnetoactive plasma. ZhETF, v. 64, no. 3, 1973, 848-857.

Rudakov, L. I. Instability and scattering of light in a diverging single-element plasma. ZhETF P, v. 17, no. 7, 1973, 382-385.

2. Effect of Strong Explosions

A. Abstracts

Gvozdeva, L. G., and A. K. Stanyukovich. Reflection from a terrestrial surface of shock waves generated from meteorite impact. Astronomicheskiy vestnik, v. 6, no. 4, 1972, 228-236.

A theoretical analysis is made of shock waves from large meteoroids entering the atmosphere, and reflected waves generated from the meteroid impact with the Earth. Four possible reflected wave configurations (Fig. 1) are examined in relation to wave destructive effects.

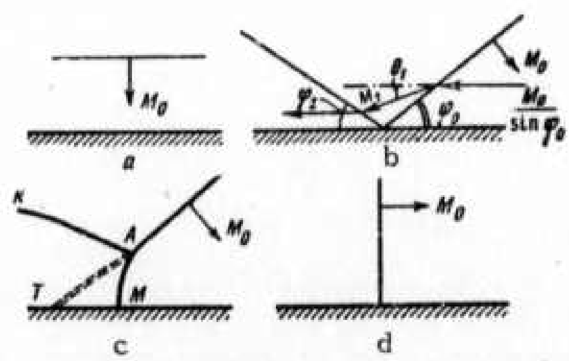

Fig. 1. Models of shock reflection:
a - normal reflection; b - regular reflection;
c - irregular reflection; d - glancing incidence.

Formulas are given for each configuration of wave patterns and gas dynamic parameters behind the reflected shock, assuming the gas to be perfect. The most complex configuration is analyzed in detail. This is the case when the angle of incidence $\varphi_0 > \varphi_{0lim}$, the point of the incident wave contact with the reflected wave (triple point A in Fig. 1c), separates from the wall, and a third shock wave (Mach wave AM) is generated. Recent experimental and theoretical studies of the Mach reflection have shown that the AM wave is curvilinear and that a vortex-type flow occurs in the region of contact discontinuity A T. The triple configuration is analyzed for a coordinate system

moving with the triple point (Fig. 2).

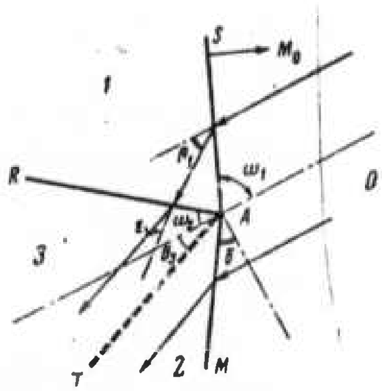

Fig. 2. Triple configuration of shock waves in a moving coordinate system.

The triple configuration is defined by the intersection of the shock polar curves described by the equations of tg θ_1, p_3/p_o, and p_2/p_o. Relative wave positions and gas dynamic parameters in all four regions can be calculated using the theory of a triple shock, assuming the angle χ of the triple point trajectory with the reflecting surface is known. Experimental χ values from the literature are given as functions of φ_o. Variation of the p_2/p_o ratio in transition from regular to Mach configuration is examined in view of its importance to the shock wave effect on terrestrial objects. Analysis of the p_2/p_o formula shows that p_2/p_o is maximum towards the end of regular reflection ($\varphi_o = \varphi_{olim}$) and decreases with the onset of Mach reflection. The cited phenomena can explain the asymmetry of the destruction perimeter from the Tunguska meteorite impact. For a gently sloping large meteorite path (Fig. 3) regular reflection occurs in the rear of the ballistic wave - Earth surface interaction region. In the front of this region first regular, then Mach reflection (in point C) occurs. Reflection is normal in the epicenter (point 0). Destruction is expected to be more extensive and at a greater distance in the regular reflection region than in the Mach region. The cited formulas have application in solving direct and inverse problems of destruction analysis.

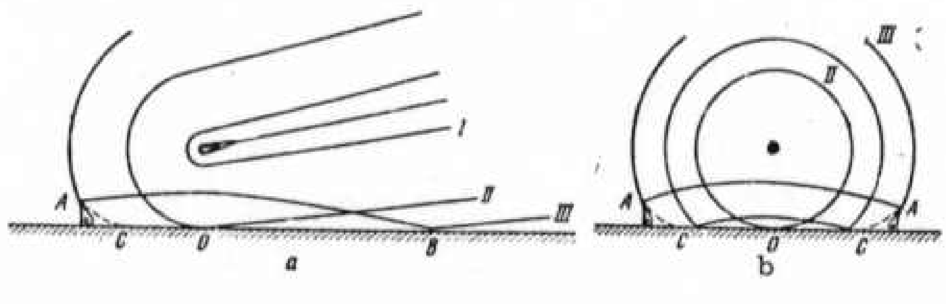

Fig. 3. Shock reflection patterns in the gently sloping path of a large meteorite: a- in a vertical plane intersecting the trajectory, b- in a vertical plane normal to the trajectory.

Sechenov, V. A., and O. Ye. Shchekotov. Pulsed x-raying of a shock wave in cesium vapors using dual x-ray tubes. TVT, no. 5, 1972, 967-972.

A description is given of the equipment and procedure for measuring the density and speed of a shock wave, based on absorption of soft x-radiation by means of two x-ray tubes. Particular attention is devoted to the accuracy of the method of density determination. It is pointed out that error in the determination of density consists of three components: a) instrumental error, including static indeterminacy and finite line thickness; b) error connected with imprecise determination of

the voltage on the x-ray tube anode at the moment of passage of the shock wave; and c) calibration error. Formulas are presented for estimating components a) and b), and methods are proposed for minimizing their effect. The minimization of calibration error is treated in depth, calibration being conducted on the basis of xenon, due to the high temperature (about 1,000° C) required for cesium. Procedures have been developed for reducing calibration error to 1%. Under the optimal conditions realizable in the experiment, the density of a shock wave in cesium vapors can be determined to within 3%.

Khanukayev, A. N., V. Ya. Bril', and V. P. Belyatskiy. Calculating shock wave parameters in a near-blast zone. IN: Sbornik nauchnykh trudov. Krasnoyarskiy politekhnicheskiy institut, no. 14, 1971, 68-83 (RZhMekh, 12/72, no. 12B199). (Translation)

A method is given for calculating shock wave parameters from the front velocity, displacement velocity and pressure. Shock wave parameters thus calculated, and the experimental values of the parameters, are analyzed for a series of rocks.

Valitova, N. R. Hypersonic wave amplifier. Otkr izobr, no. 35, 1972, no. 359744 (Translation)

The title amplifier is composed of the signal generator, a pumping source, a sound transmitter, and coaxial resonator. To increase amplification and to excite a transverse wave, the excitation end of the resonator central rod is shaped as a frustum of a cone; a piezoelectric class 3 m crystal such as lithium niobate or lithium tantalate, is used as the sound transmitter.

Yashin, P. S. Mechanism of molten metal ejection from a crater during erosion processing. IN: Sbornik. Tekhnologicheskiye voprosy elektrokhimicheskoy obrabotki materialov, Kazan', 1972, 139-141 (RZhKh, 24/72, no. 24L226) (Translation).

The mechanism of metal ejection during electro-erosion processing is developed on the basis of a point explosive charge model of a point electric pulse. Calculation of the pulse parameters indicates that metal melts and partly vaporizes by thermal effect of the pulse. Subsequently, molten metal is ejected by a secondary shock wave, i. e., owing to the collapse of gas bubbles which generate a powerful cavitation shock.

Krishtal, M. A., I. A. Goncharenko, Yu. I. Vayner, and S. N. Verkhovskiy. Structural properties variations in metals and alloys from explosive loading. FiKhOM, no. 6, 1972, 84-88.

An experimental study is described of the structure and mechanical characteristics of type Kh18N9T steel, Armco iron, and OT-4 alloy elliptical end-plates produced by explosion stamping of 2 mm thick cold rolled sheets. The purpose of the study was to determine the optimum parameters of explosive loading for producing a given metal form having specified characteristics. Loading was generated by underwater explosion of 25-70 g. TNT charges at a 10-150 mm distance R from the blank. Pressure P exerted on the blank varied from 1,000 to 10,000 atm. It is shown (Fig. 1) that at a constant explosive charge weight G, there

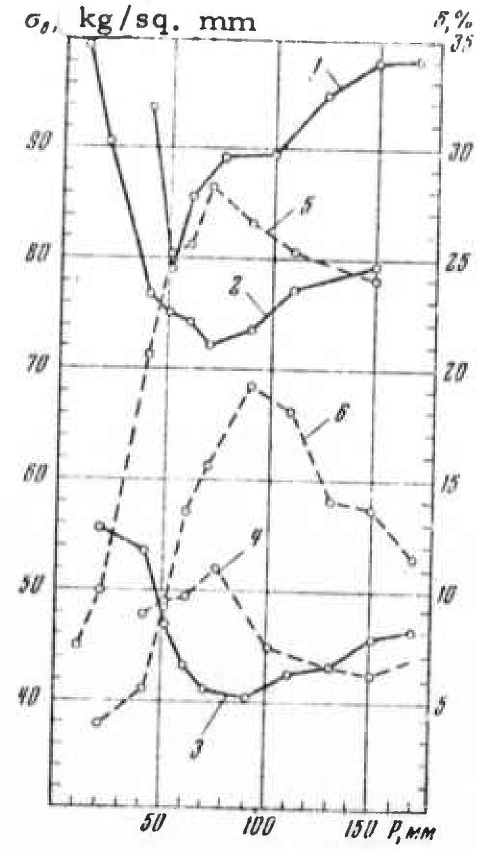

Fig. 1. Tensile strength σ_b and relative elongation δ versus distance R at a constant G. Curves: 1 to 3 - σ_b, 4 to 6 - δ, 1 and 4 - OT4, 2 and 5 - 1Kh18N9T steel, 3 and 6 - Armco iron.

exists an optimum distance R at which work hardening is minimum; optimum R increases with heavier charges. Calculations show that a constant pressure pulse $u = P\tau$, where τ is duration of shock wave effect, corresponds to the condition of minimum work hardening, regardless of G and R values. The empirical formula

$$R = 0.1251 G^{0.706} \tag{1}$$

was established for a minimum work hardening of Kh18N9T steel, under given conditions of stamping.

Tabulated x-ray analysis data confirmed that stamping with a minimal work hardening can be achieved with variable charges G. The minimum variation in physicomechanical characteristics in explosion stamping is interpreted in terms of the synchronized shift of atoms in a shear plane, and homogeneous nucleation of dislocations. At a small u value, deformation proceeds by dislocational mechanism only, leading to work hardening, and often destruction, of the material. At an optimum R or optimum u, both cited mechanisms interfere to decrease work hardening. At a high u the excess kinetic energy of the plate is spent for work hardening and often causes destruction as the result of shock wave interference.

Medvedev, Yu. A., B. S. Punkevich, and B. M. Stepanov. Results of a study of space-time conductivity distribution in a blast zone. FGiV, no. 3, 1972, 417-422.

Conductivity σ distribution in time was studied by probing a blast zone using a 5 MHz alternating magnetic field. The blast zone was created by exploding a 50/50 TNT-RDX charge in the center of a magnetic coil wired to an impedance bridge arm. The bridge was balanced against an identical coil before the blast. Oscilloscope traces were recorded of the signal $u/u_o = F(t)$ from the bridge unbalanced by the explosion. Calibration curves of u/u_o versus σ show that the function $r^{-3}(t)F(t)$, where r is the radius of the calibration sphere or spherical zone, provides information on the σ distribution pattern in the blast zone. Analysis of the experimental data reveals that σ is concentrated in a $\Delta'(t)$ thick layer of the blast zone, near the shock wave front. An expression for the effective thickness of the conductive layer is derived.

Andriankin, E. I., V. K. Bobolev, and A. V. Dubovik. Shock heating of a liquid explosive layer. FGiV, no. 3, 1972, 408-416.

Theoretical and experimental evaluations were made of the temperature profile T(t) and peak temperature T_m in a thin liquid explosive layer (e.g., nitroglycerin) heated by impact of a striker. The impact-induced process in a thickness layer $h \leq R$ (R is the striker base radius) is described based on Khariton's two-stage concept. In the first stage, the liquid layer is compressed at a constant rate; in the second stage it spreads ($h \rightarrow 0$) under a constant load corresponding to a maximum pressure with the limit p_x at $h = 0$ (idle impact). In the first inertial stage $Re > 1$ and in the second viscous stage $Re < 1$. The boundary position between the two stages is formulated in terms of the parameter h_1, which is determined from the heat equation. The initial heating is considered to be an adiabatic process. The temperature is expected to reach a peak value at an intermediate time in the compression process, which is considered to be the most dangerous movement of an explosion. The temperature dependence of the liquid viscosity μ is the second most important factor of a T_m decrease.

A simple series of experiments is described, in which 0.25 and 0.5 mm. thick nitroglycerin layers were shock-compressed between two coaxial rollers. The shock velocity of a 5 kg load on the upper roller varied from 1 to 4 m/sec. In all experiments, no explosion was observed with $T_m <$ critical T_b. During an adiabatic induction period of 10^{-5} sec, the temperature rose to $\sim 300^\circ$ K. Calculations based on varying assumed mechanisms of liquid explosive heating indicate that, under the given experimental conditions, T_m is an order of magnitude lower than T_m during adiabatic heating and is lower than the ignition point of nitroglycerin. The temperature reaches a maximum value on the periphery of the striker, where pressure is nearly normal.

Kozachenko, L. S., and B. D. Khristoforov.
Surface phenomena from underwater explosions.
FGiV, no. 3, 1972, 433-439.

Results are presented of experimental studies on underwater explosions. The initial rise rate of the plume, changes of its height with time, and parameters of the surface waves were recorded from the underwater detonation of 100 kg spherical charges of cast trotyl at various depths in reservoirs with a depth of up to 12 charge radii, $R_o \approx 0.25$ m. Tests were conducted in a reservoir 87 m long, the level part of the sandy bottom being 20 m wide. The development of the plume was observed from four towers 9.5, 12.5, 12.5, and 23.3 meters high, at distances of 355, 100, 100 and 112 meters, respectively, from the center of the explosion. Motion pictures were taken by four cameras at 2000, 32, 32, and 0.5 frames per second. Surface-wave parameters were measured by wave graphs operating on the basis of measurement of the electrical resistance of water. The results of the tests are presented in photographs, wave graphs, and curves.

It is shown that the experimentally obtained relationship of the maximum diameter of the plume neck $\overline{D}$ to the charge depth $\overline{h}$ (where linear dimensions correlate to a charge radius $R_o = 0.053C^{1/3}$ m, with C = the charge weight, kg), when the reservoir depth $H_* \geq 12$, at charges weighing from 100 to 2.5×10^{-4} kg, is subject to the law of geometric similitude; this permits the energy of the explosion to be determined on the basis of the measured maximum diameter of the plume neck. Photo sequences of plume development are included.

Sobin, O. A. Experimental study of the destruction zone during cutting of survey pits by cratering explosions. IVUZ Geologiya i razvedka, no. 11, 1972, 120-122.

The purpose of the study was: 1) an experimental refinement of the determination of crater shape for intensified single and interacting cratering charges and the line of least resistance W $\leq$ 1.5 m, which corresponds to the single-interval excavation of geological survey trenches by explosions; 2) selection of a formula for calculating the true-crater volume on the basis of actual measurements. The experimental research was conducted at four trench sites of the Chita Geological Administration, and consisted of measuring true craters and trench sizes, formed by single and interacting charges. The test shots were fired on horizontal and slightly inclined surfaces in thawed and frozen sandy-argillaceous deposits. Concentrated charges (2 to 30 kg) placed both in kettles and in alveoles were used.

It was established that the true-crater shape resulting from intensified cratering charges closely resembles a cylinder joined to a sphere, and that the true cross-section shape of trenches resulting from interacting charges, is similar to that of a crater. Two formulas are presented for computing the true crater and trench volume on the basis of an ellipsoid of rotation for a single charge and for interacting charges.

Onishchenko, Yu. A. Tensor properties of rock massif parameters. IN: Sbornik. Problemnyye voprosy mekhaniki gornykh porod, Alma-Ata, Izd-vo Nauka, 1972, 256-263 (RZhMekh, 11/72, no. 11V743) (Translation)

Tensor parameters are introduced to describe a rock massif with statistically oriented structural imperfections, e.g., stratification, cleavage, and fracturing. The most characteristic tensor properties (material anisotropy) are expressed by the $f_{i,j,\ldots,k}(a)$ structural function, where the variable a is the characteristic of the degree of imperfection, e.g., crack concentration. The K_{st} statistical function, a characteristic of the imperfection disordering, is treated as a scalar. A random massif parameter is given by the formula $\Pi_{i,j,\ldots,k} = \Pi_m f_{i,j,\ldots,k} K_{st}$, where Π_M is a material scalar parameter. A rock massif can be described by a set of structural tensor functions or the spectrum of imperfect states. Assuming the states are superposed, the author proposes to determine a structural function for the total massif by solving Volterra's integral equation with a difference kernel.

Nazarov, G. N. New data on elastic wave propagation rate in ground massifs. IN: Sbornik. Inzhenerno-stroitel'nyye izyskaniya, Moskva, Stroyizdat, no. 2(27), 1972, 50-59. (RZhMekh, 12/72, no. 12V673) (Translation)

A theoretical study is presented of in-depth variations of propagation rate in various rocks of the earth's crust. Humid clay, quartz and feldspar sands with minimum and maximum packing density in dry, humid, and water-saturated states, solid rocks of different strength and

hollowness and with different fillers were studied. The possibility is shown of significant rate variations as functions of the filler type in solid as well as in loose rocks. It is concluded that ultra-low rates may develop in solid rocks whose cracks are either filler-free or are filled with a dry sandy-argillaceous material. However, the rate of longitudinal waves propagation in solid rocks may also increase sharply on account of irrigation. It is noted that the newly cited data have been confirmed by experiment.

Bakhtin, G. A. Method of studying shock wave parameters in rocks. IN: Sbornik. Fiziko-mekhanicheskiye svoystva gornykh porod ugol'nogo mestorozhdeniya Urala i Sibiri. Chelyabinsk, no. 1, 1971, 10-19. (RZhMekh, 12/72, no. 12V815). (Translation)

The shock wave is considered to be the determining factor in rock destruction by blasting. A method is introduced to determine shock wave parameters in the near-blast zone. The method consists of developing the equation of state of a rock, using experimental shock wave propagation rates at different distances from the blast center.

Reshotka, Kh. S., K. N. Tkachuk, and M. A. Bondarenko. Application of conformal mapping to solving problems of rock destruction from explosions. IN: Sbornik, Doslidzh. teoriyi funktsiy kompleks. zminnoy ta yiyi zastosuvan'. Issled. po teorii funktsiy kompleks. peremennoy i yeye primeneniyam, Kiyev, 1972, 145-149. (RZhMekh, 12/72, no. 12V818).

The problem of explosion effects on a rock surface is treated in the framework of Academician M. A. Lavrent'yev's concepts, while

neglecting rock compressibility and strength characteristics. The assumed negligibility of the latter in relation to inertial forces is valid only for initial motion. It is known that in this case the potential of the medium particles initial velocity in the turbulent region is a harmonic function and satisfies a Laplace equation. In the case of a plane wave, which is treated exclusively, the problem is reduced to determining harmonic functions in the $y < 0$, $|x| < \infty$ half-plane with given discontinuity conditions at the $y = 0$ boundary. A rigorous solution of this problem is obtained by the method of functions of a complex variable. In this way the initial velocity field was determined in implicit form. The demolition belt is defined as the locus where the unit momentum flow is equal to the unit work of rock destruction, the latter assumed to be a known physical constant of the material.

Panfilov, V. S. Hydrogeothermal origin of earthquakes. IN: Sbornik. Tezisy dokladov i soobshcheniy na 2-y nauchno-tekhnicheskoy konferentsii Gidroproyekta, Moskva, part 2, 1972, 93-95. (RZhMekh, 12/72, no. 12V825). (Translation)

According to the briefly-reported author's concept, earthquakes are generated by energy concentration in water filling of fractures. An earthquake occurs when water is ejected from deeper and warmer parts of a fracture. Elastic strain energy thus liberated is converted into seismic waves. A similar mechanism is proposed for deeper earthquakes, in which case a substance subject to phase transitions plays the role of water.

Darbinyan, S. S. Calculating resistance forces in the theory of seismic resistance. Byulleten' po inzhenernoy seismologii. Mezhduvedomstvennyy sovet po seismologicheskomu i seismostoykomu stroitel'stvu AN SSSR, no. 7, 1972, 66-69. (RZhMekh, 12/72, no. 12V830). (Translation)

Calculations are shown which are based on equations of seismic resistance with allowance for resistance forces. Numerical calculations using a digital computer have shown that inaccurate formulation of resistance forces in equations of structure oscillations may cause great errors in calculating the magnitude of seismic loads.

Arynov, A. A., and A. A. Batyrkanov. Calculating pneumatic isolation of structures from seismic waves simil r to those of the Tashkent earthquake. IN: Trudy Kirgizskogo universiteta, Seriya fizicheskikh nauk, no. 1, 1972, 39-45. (RZhMekh, 12/72, no. 12V839) (Translation)

The motion is analyzed of a rigid body isolated from the ground by air-filled balloons. The equation of motion of the body is derived and analyzed. An example is given of time dependence of acceleration within a zero-to-two second period.

Sapozhnikov, A. I., A. A. Mikhaylov, L. F. Shtan'ko, V. A. Yelsukov, Ye. A. Gulyayev, and S. I. Chernyshov. Two trends in the development of the science of seismic resistance. IN: Sbornik. Seysmostoykost' gidrotekhnicheskikh i portovykh sooruzheniy Primor'ya, Vladivostok, part 1, 1972, 7-9. (RZhMekh, 12/72, no. 12V922). (Translation)

Two- and three-dimensional design trends are noted in the development of the science of seismic resistance of buildings and structures. The second trend is considered to be the most effective. A list of studies is given in which design methods for buildings and structures are presented in the framework of a three-dimensional system. The cited design methods are recommended for use in designing buildings and structures in seismically active zones.

Sokolovskiy, S. V. Calculating seismic pressure at dams and coastal wave barriers. IN: Sbornik. Seysmostoykost' gidrotekhnicheskikh i portovykh sooruzheniy Primor'ya, Vladivostok, part 1, 1972, 38-46. (RZhMekh, 12/72, no. 12V925). (Translation)

An approximate "hydraulic" method is introduced to calculate the pressure of water set in motion by earthquake. The cases are examined of one-sided pressure exerted on dams and two-sided pressure exerted on breakwaters.

Antonyuk, A. Ye. Effect of foundation design on seismic resistance of structures. IN: Sbornik. Proyektirovaniye i stroitel'stvo zdaniy v seysmicheskikh rayonakh UkrSSR i Mold SSR, Kishinev, Izd-vo Timpul, 1972, 163-175. (RZhMekh, 12/72, no. 12V841). (Translation)

Methods and results are given of dynamic testing of building models with different foundation designs. The purpose of the test program was to evaluate the effect of foundation design on magnitude of seismic loading of the structures. The above-ground component of the model was a rigid metallic frame with four pig iron plates, each weighing 20 kg. Six different foundation types were tested: a plate with cushion, a plate without cushion, a strip foundation, conic foundation, elastic foundation, and strip foundation with cushioning soil layer. Seismic load magnitude was found to be minimum for the models having the plate foundation with cushion and strip foundation.

Belyy, V. D., and V. Ye. Popov. Analysis of stressed state of prefabricated buildings and their structural elements under seismic loading conditions. IN: Sbornik. Proyektirovaniye i stroitel'stvo zdaniy v seysmicheskikh rayonakh UkrSSR i Mold SSR, Kishinev, Timpul, 1972, 107-117. (RZhMekh, 12/72, no. 12V954). (Translation).

Full-scale and laboratory research data on seismic resistance of prefabricated buildings are examined. The period and mode of the buildings' lateral motion and its damping constant are analyzed. An experi-

mental study was made of the elements' strength and strain characteristics, as well as the normal and tangential adhesion of cement mortar to stone. Full-scale dynamic testing of the building panels indicated that prefabricated buildings on common grounds are more rigid than all brick or precast panel buildings. The method of determining design rigidity characteristics was modified to take into account one-sided stiffening work of partitions and straight arches. The effect was studied of the vertical component of seismic activity on solidity of masonry. In conclusion, recommendations are formulated on design and construction of prefabricated buildings in seismic zones, specifically, on improving their three-dimensional work characteristics and minimizing relative shifts of their elements.

Lubenets, V. A., V. S. Naumenko, G. S. Shkrebko, and A. Ye. Umnov. Localization of air shock waves from massive explosions. Gornyy zhurnal, no. 8, 1972, 45-47.

Construction and performance are described of water-filled barriers, installed in Krivoy Rog iron mines in 1971. The barriers were designed to prevent destruction of underground structures and communications by air shock waves from detonating 1 to 300 t explosive charges. The barrier consists of wooden shelves on which water-filled polyethylene bags were placed. In a cited case a barrier was installed in the Tsentral'naya shaft cross-section of the mine and performed very efficiently in a 10 m^2 cross-section of sublevel caving. In both block caving and sublevel caving systems air shock waves from massive explosions of 22.4 t and 40.1 t explosive charges, respectively, were damped without producing substantial destruction on the main haulage levels or receiving level. Localization of the air shock wave occurs by wave front deceleration and superposition of

successive waves as the result of interaction with the practically incompressible water barrier. The simplicity of the structure and its ease of construction, its highly efficient localization of shock waves, and minimization of dust and poisonous gases from massive explosions are among the cited advantages of the water-filled barrier.

Yaralov, L. K., V. S. Kuz'min, and A. S. Marshalkovich. Application of new optically sensitive materials in models of explosive demolition of rocks. IVUZ Gorn, no. 5, 1972, 84-86.

The dynamic opticomechanical properties were investigated of a homopolymer of diallyl phthalate (DAF), and copolymers of DAF with diallyl maleinate (DAM), with DAF to DAM mole ratios of 3:1 and 1:1. The DAF polymerization and the DAM copolymerization were done in 2.5% benzol peroxide and 1% ditertiary butyl peroxide. The new optically sensitive polymers were then used as models of the explosive demolition of rocks. The stress waves were analyzed by the method of dynamic photoelasticity. Flat 200 x 100 x 3 mm plates of the polymer materials served as models, subjected to loads from the detonation of 30 mg of lead azide.

Results show that polymers based on diallyl esters are preferable to PMMA and ED-6 epoxy resin solidified by malein anhydride (ED-6M), for use as models of explosive demolition of rocks by the method of dynamic photoelasticity. Retaining high optical sensitivity, these polymers are distinguished by higher density and greater brittleness. With an increase in the mole fraction, the brittleness increases, and the attenuation coefficient decreases of DAM in the copolymer.

A separate experiment revealed that the maximum radii of destruction in 85 x 85 x 3 plates of ED-6M, DAF, DAF:DAM = 3:1, and DAF:DAM = 1:1 comprised 10, 16, 22, and 28 mm, respectively, from the detonation of 15 mg of lead azide. Cracks were observed on the free surface of the DAF and DAM copolymer plates.

B. Recent Selections

i. Shock Wave Effects

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3. Geosciences

A. Abstracts

Katrenko, V. G., and V. I. Ulomov. Automation of seismological observations in Uzbekistan; Chapter 7. IN: Akademiya nauk UzbSSR. Institut seysmologii. Seysmichnost' zapadnogo Uzbekistana (Seismicity of western Uzbekistan). Tashkent, Izd-vo Fan, 1972, 138-144.

Since September 1970, the Tashkent Geodynamic Experiment Site has been using a telemetering system for the transmission of earthquake observation data from three borehole seismometers to the Tashkent Central Seismological Observatory. The system is being applied to the study of earthquake precursors, with subsequent real-time data processing on the Tashkent Observatory's Minsk-22 computer. The borehole seismometers are positioned in a triangle 40, 50, and 60 km on a side (see Fig. 1) with the Tashkent Observatory making the fourth point in the "array." The maximum distance from any point to Tashkent is 33 km. The system has a dynamic range of 60 db and a 0.5-10 Hz frequency range. Off-the-shelf radio transmitters operating on commercial line current are used for data transmission, and they incorporate channel multiplexing and FM-FM modulation. The block diagram in Figure 2 illustrates a typical system with a borehole seismometer. A ground-level system is available which uses an SKM seismometer.

Fig. 1. Arrangement of Radio-Telemetering Borehole Seismometers and Tashkent Observatory.

1 - Borehole seismometers; 2 - Tashkent Seismological Observatory; 3 - Tashkent Geodynamic Experiment Site. Circular zones represent epicenter determination error, i.e., < 1 km, ± 2-3 km, and ± 4-5 km.

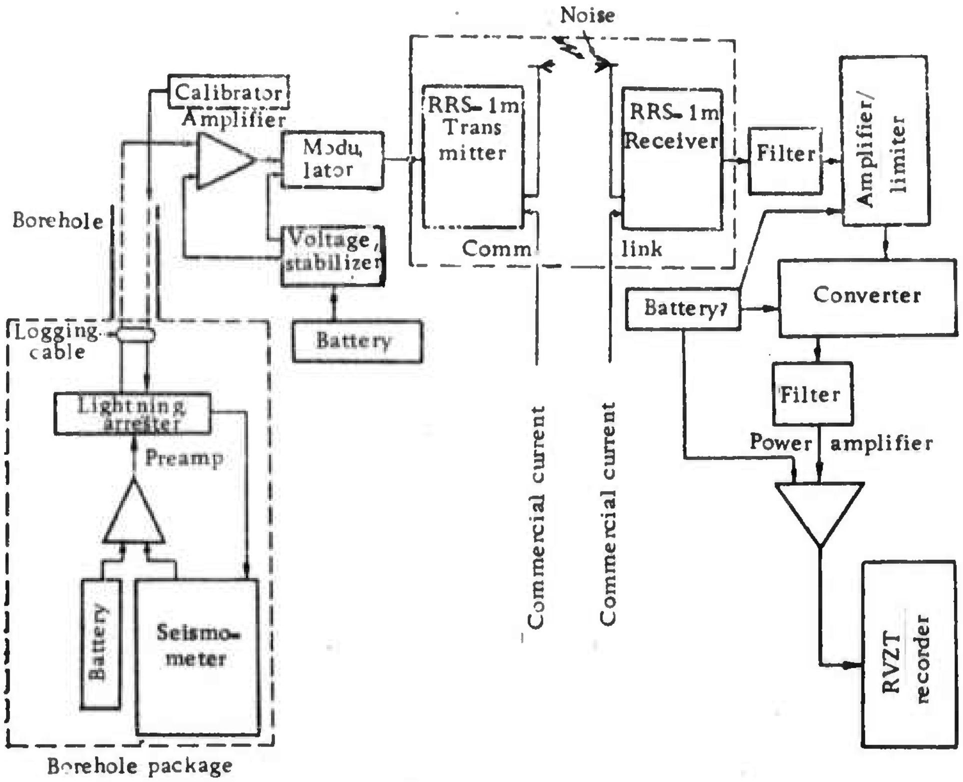

Fig. 2. Block Diagram of Seismic Data Telemetering System.

The system illustrated above has the following general characteristics and errors:

Frequency response	flat from 0.5 to 10 Hz
Dynamic range (less transmission and recorder ranges)	no less than 60 db
Nonlinearity	0.5 - 1 %
System noise (reduced to input)	less than 0.3 μV
Operating temperature range	-15 to + 45° C
Data transmission range:	
within 60 db	20 - 30 km
within 40 db	30 - 50 km
Magnification	$5 \cdot 10^3$

The present use of analog recording has limited the dynamic range to 40 db. Coverage of the 60 db range can be provided by expansion digitization at the Tashkent Observatory. The system covers about 1000 km^2 of the 10,000 km^2 Tashkent Geodynamic Experiment Site. Within a 30-km radius of Tashkent, the error in determining focus coordinates is ± 1 km; from 30 - 60 km, the error is about ± 2 - 5 km, while at 60 - 200 km it is ± 5 - 15 km. For focal distances over 200 km, S - P differences must be used although azimuth can be determined; the coordinate determination error at these distances is ± 20 - 30 km. Assuming a homogeneous medium and a point source, a formula is presented from which nomograms were derived for coordinate determinations. Present systematic errors stem from not taking crustal-structure characteristics into account. These errors will be corrected by using explosions whose time and coordinates are precisely known. It is concluded that this system with its three radio telemetering seismometer systems and central seismic-recording and data collection/processing point has a resolution capability a half to an order greater than discrete systems having identical dynamic parameters.

Troyan, V. N. Resolution in optimum reception of seismic waves with curvilinear cophasal axes. IN: Leningradskiy universitet. Uchenyye zapiski, no. 366, 1972, 194-201.

The wave field model considered in this study is

$$U_{ki} = \begin{cases} \text{either} & f_{0ki} + n_{ki}, \\ \text{or} & \frac{1}{2} f_{1ki} + \frac{1}{2} f_{2ki} + n_{ki}, \end{cases}$$

where f_{0ki}, f_{1ki}, f_{2ki} are deterministic components; n_{ki} is a random component, which is assumed to be centered, normal, stationary and uncorrelated along the x-axis.

Analysis of the resolution of seismic waves is reduced to the determination of the unreliability of the choice between two alternatives given above. Unreliability is expressed as $A^{-} = F(-\frac{1}{2}\alpha)$, where F is the integral function of the normal distribution.

The analysis was performed for the case when amplitude and phase spectra of f_0, f_1 and f_2 waves are equal. Formulas for α^2 are developed in terms of kinematic parameters for: a) the random component correlated with t; b) the random component uncorrelated with t; and c) the random component is indiscernible.

In addition formulas for α^2 are developed for the case of seismic waves with parabolic time-distance curves, and for diffracted waves; examples illustrating resolution for both waves are given.

Volkov, I. Ye., and T. B. Yanovskaya. <u>Distribution characteristics of P-wave amplitudes.</u> IN: Leningradskiy universitet. Uchenyye zapiski, no. 366, 1972, 137-147.

The distribution of P-wave amplitudes is analyzed, assuming that dispersion of experimental data is introduced, mainly, by nonuniformity of the source radiation. Analytical expressions are developed for amplitude distribution at a fixed point, for fixed directions of the coordinate axes in the source, and random direction of the seismic rays.

An analysis of the amplitude distribution is made for two cases: 1) the intensity and distance of the source are known (M is known); and 2) the intensity of the source is a random variable. In the first case, the expression developed for the distribution density for A^* is

$$p_0^*(A^*) = \frac{2 \cdot 10^{A^*} \ln 10}{\pi \sqrt{1 + 10^{A^*}}} K\left(\frac{1 - 10^{A^*}}{1 + 10^{A^*}}\right). \tag{1}$$

where $A^* = \lg_{10} A'$, $A' = A/C$, $A = C \sin^2\theta \, |\sin 2\varphi|$, where θ and φ are angular coordinates of the fixed point, and C is a constant dependent on the intensity and distance of the source.

In the latter case, the distribution density for A^* is

$$p_n^*(A^*) = \int_{-\infty}^{0} p_0^*(x)\, p_M^{(n)}(x - A^*)\, dx, \tag{2}$$

where $p_o^*(x)$ is the distribution density for observed amplitudes, $P_M^{(n)}(x)$ is the distribution density for M, and n is the number of earthquakes used for the M determination. It is shown that $p_n^*(A^*)$ approximates experimental distribution, while $p_o^*(A^*)$ does not. The distribution density for the errors inthe A^* determination is characterized by asymmetry. The dispersion of $p_o^*(x)$ is $\sigma_o^2 = 0.29$. The dispersion of M and A^* are σ_o^2/n and $\sigma_o^2[1 + (1/n)]$ respectively.

The conformity of the experimental and theoretical distributions are analyzed, using data on Far East earthquakes with $\Delta = 600 - 1200$ km. It is shown that experimental and theoretical distributions are in good agreement, thus giving evidence that the assumption on which the analysis was based is justified.

Chamo, S. S., et al. Stratification of the crystalline basement of the Russian plate, based on seismic data. IN: Moskovskoye obshchestvo ispytateley prirody. Byulleten'. Otdel geologicheskiy, no. 5, 1972, 72-77.

The results of a study of the structure of upper consolidated crust in the Russian plate, along the Kupyansk-Voronezh-Lipetsk-Ryazan'-Tuma DSS profile are described. The profile crosses the Voronezh anteclise, the Pachelma downwarp, and the Tokmovo uplift.

An inferred inhomogeneous thin-layered model of the upper crust is shown. The most prominent seismic interface is d_1°, immediately below the crystalline basement surface. Its refractor velocity is relatively consistent, varying from 6.0-6.2 to 6.4-6.6 km/sec; its local relief is quite different from that of the crystalline basement surface. This interface was reliably identified also by gravity and magnetic data.

The corresponding seismic interface is found in many other regions, such as western and eastern Turkmenia, western Kazakhstan, the Peri-Caspian megadepression, the central and southeastern parts of the Russian plate, including a similar interface in the Ukrainian shield.

Abdulin, A. A., and A. N. Antonenko. <u>Study of the earth's crust and upper mantle in Kazakhstan.</u> IN: AN SSSR, Vestnik, no. 11, 1972, 18-22.

The results of crustal studies performed by various geophysical methods in Kazakhstan are reviewed. DSS profiles (see Fig. 1) and seismo-

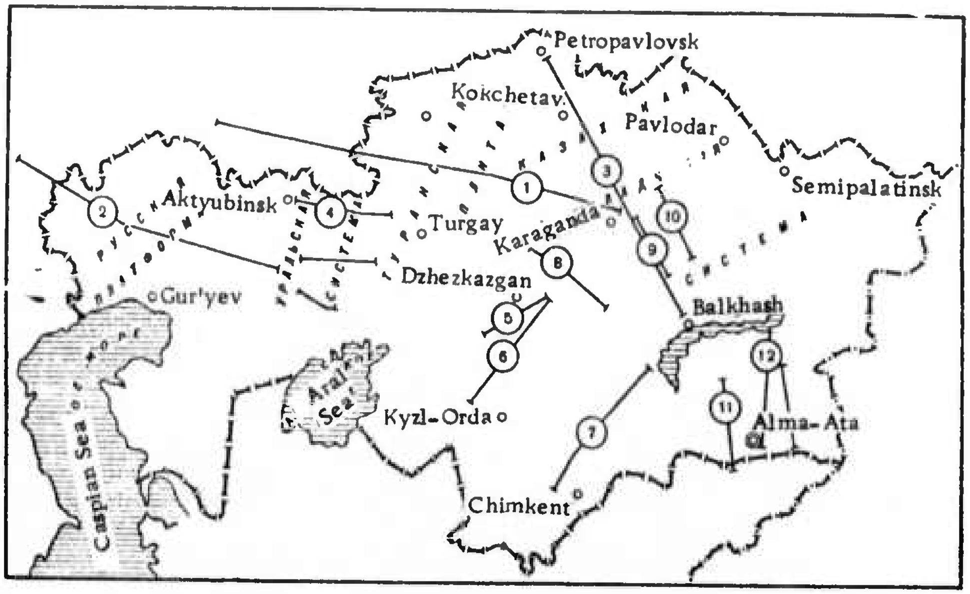

Fig. 1. Location of DSS Profiles in Kazakhstan.

1- Temir-Tau - Kuybyshev (1969); 2- Chelkar - Volgograd (1971); 3- Balkhash - Petropavlovsk (1963); 4- Aktyubinsk (1968); 5- Dzhezkazgan (1960); 6- Kzyl-Orda - Dzhezkazgan (1967); 7- Aryst' - Balkhash (1966); 8- Karazhal; 9- Sherubay - Nurinsk (1964); 10- Karkaralinsk (1963); 11- Kaskelen (1968); 12- Issyk (1969).

logical sections totaled 14,000 km. Detailed DSS studies were performed in the Dzhezkazgan-Sarysu depression, the Uspenskiy tectonic zone, and the Mugodzhary region.

General characteristics of the crust in Kazakhstan are: pronounced basement surface and Moho discontinuity less pronounced and intermittent Conrad discontinuity; and increased thickness and refractor velocity along the Moho discontinuity, as compared with adjacent regions.

In northern Kazakhstan (Kokchetav block), refracted waves associated with the upper mantle attenuate sharply and are not recorded continuously. An extensive fault zone penetrating the upper mantle has been identified.

In central Kazakhstan, the crustal thickness increases. The following relations between surface and abyssal structures have been established: the abyssal fault zones identified are confined to boundaries of synclinoria and anticlinoria; the Uspenskiy tectonic zone is traceable to a depth of 20 km.

In the Mugodzhary region (southern part of the Ural folded system), the crust is distinctly divided into blocks with different deep structure and thickness (see Fig. 2).

The crustal thickness in the Mugodzhary region is greater by 6-8 km than that of the adjacent Turanian plate. The Moho and Conrad discontinuities occur at depths of 43-55 and 18-24 km, respectively. The upper mantle in the Mugodzhary region has layered structure. A number of conversion surfaces have been identified at depths of 54-57, 62-66, and 165-170 km (similar to the central Urals).

The combined interpretation of different types of geophysical data revealed a specific zone in the upper mantle of the Mugodzhary region which is characterized by: high velocity, excessive density, relative coolness, high electric conductivity, and high rigidity. It is assumed that this zone is underlain by a low velocity zone occurring at 160-180 km (occurring at 80-100 km in adjacent regions).

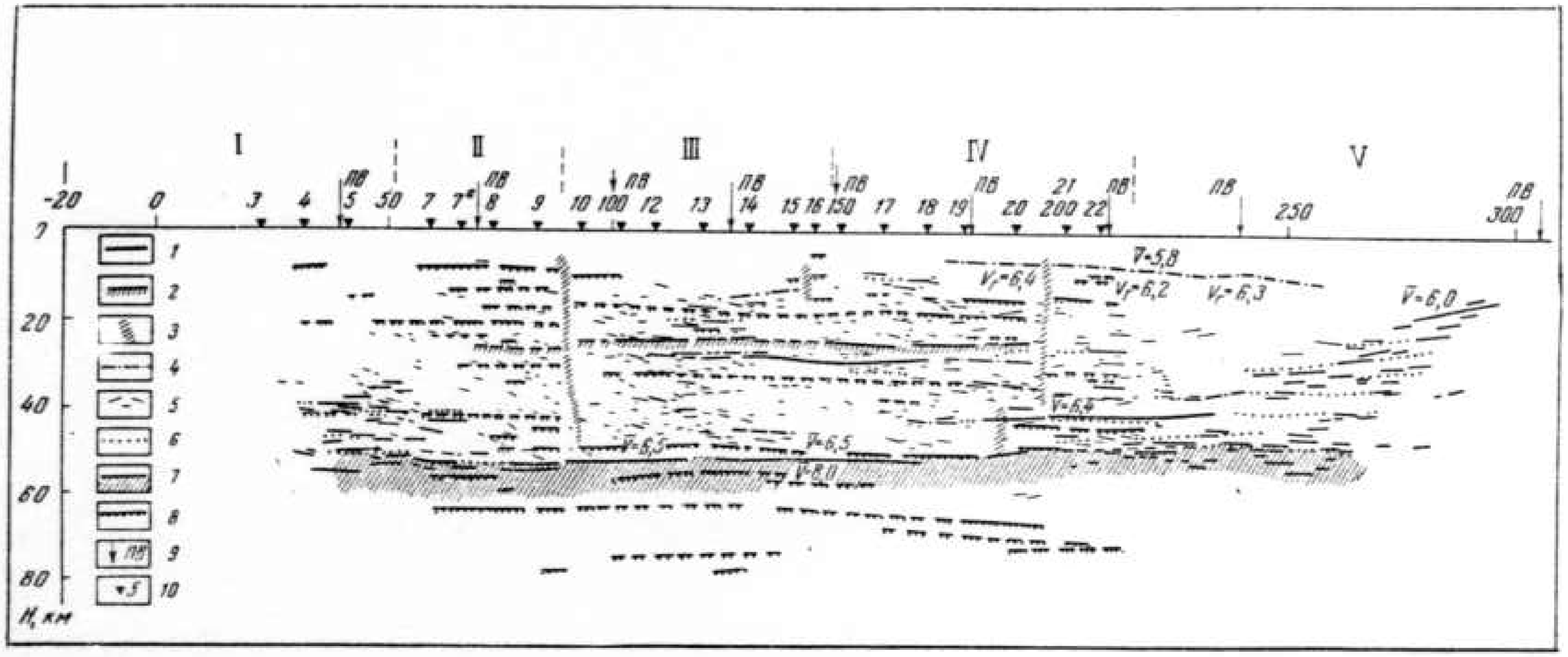

Fig. 2. Crustal Section along the Aktyubinsk Profile (from DSS and converted wave method from earthquake data).

Anticlinoria and synclinoria: I - Or'-Ileksa, II - greenstone zone, III- eastern Ural, IV - Irgiz, V - Trans-Ural. 1- Seismic interfaces determined reliably from reflected and refracted waves; 2- "basaltic" layer surface; 3- fault zones; 4- refraction surface determined from first arrivals; 5- reflection surfaces (from DSS); 6- assumed reflection and refraction surfaces; 7- Moho discontinuity; 8- conversion surface; 9- shot points; 10- observation points.

Mavlyanov, G. A., et al. Pcssible use of local variation of the geomagnetic field for earthquake prediction. Uzbekskiy geologicheskiy zhurnal, no. 1, 1973, 68-71.

The results of observations of the variations of the total intensity of the geomagnetic field at the Tashkent Geodynamic Experiment Site, located within a seismogene flexure-fracture zone, are discussed. The Experiment Site consists of two sections parallel to the seismogene structure and one perpendicular to it (see Fig. 1) and indicated by AB, CD and EF, respectively. Observing points (51) are spaced 4-5 km apart,

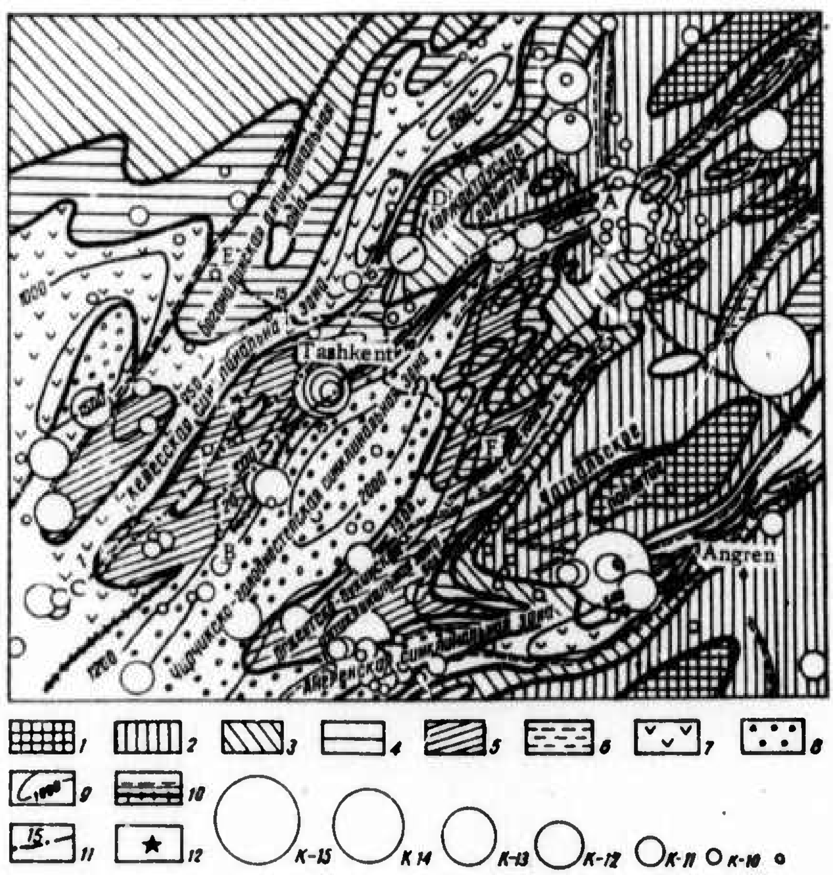

Fig. 1. Seismostectonic Map of the Tashkent Geodynamic Experiment Site.

1-7 - Areas of intensive uplifting, onset at different periods (from Miocene to Anthropogene); 8- area of present subsiding; 9- isopachs of the Neogene-Anthropogene sediments; 10- faults; 11- observation points; 12- epicenter of the Abay-Bazar earthquake of 9 February 1971; 13- earthquake epicenters; AB- eastern section; CD- western section; EF- transverse section.

and the observations made with PM-5 proton precession magnetometers during 1968-71 (3 series in 1968, 1 in 1969, 3 in 1970, and 2 in 1971) are analyzed.

Noticeable variations of the intensity of the magnetic field were observed during 1969-71 on two sectors of the western section (CD), at its intersection with section EF (observation point 13) and on its southern part (observation points 4-10). The sharp change in the intensity of the magnetic field of $\Delta T = -23\gamma$ which was detected from 1968 to 1969 at observation point B is attributed to the variation in the pressure regime in the gas storage within a 20-40-m-thick bed-collector in the area.

However, the monotonic variations of T detected during a 2.5-year period on the southern sector of the western section (CD) (see Fig. 2) are attributed to tectonic activity in the Tashkent seismogene zone. During

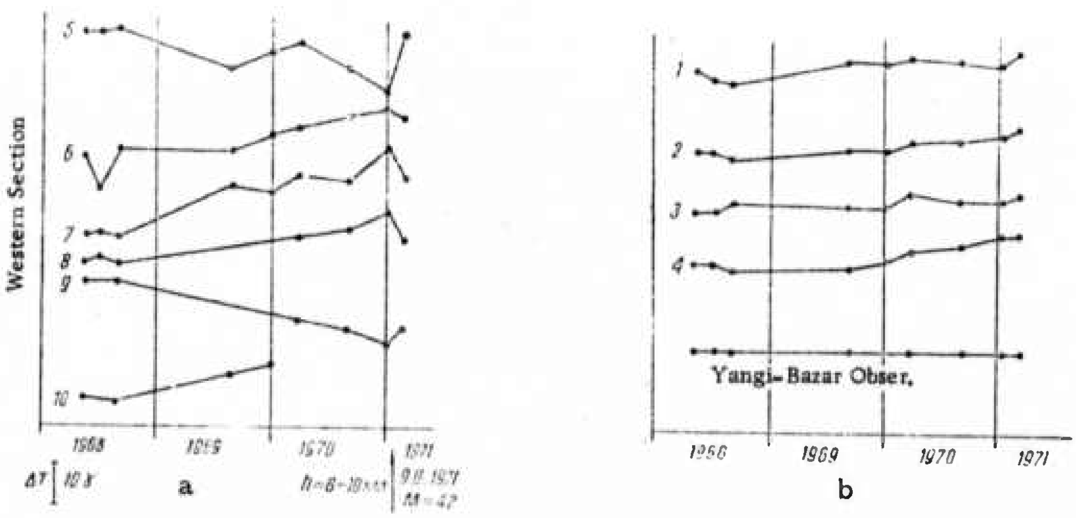

Fig. 2. Variation of the Geomagnetic Field, Anomalous (a) and Normal (b).

that period, ΔT = -15γ was observed at points 5 and 9; ΔT = $+13\gamma$ at points 6 and 8 and ΔT = $+23\gamma$ at point 7. For example, a month prior to the Abay-Bazar earthquake of 9 February 1971, the T variations were very pronounced (see Fig. 2). During the 20-25-day period after the earthquake, ΔT variations with sign opposite to that prior to the earthquake were observed. The same pattern of variation was detected after the Khalkabad earthquake of 10 February 1972. It is concluded that the appearance of seismomagnetic effects prior to tectonic earthquakes is proven, and that variations of the geomagnetic field can be used for earthquake prediction.

Riznichenko, Yu. V., and S. S. Seyduzova. <u>System of average power spectra of earthquakes</u>. IN: AN SSSR. Izvestiya. Fizika Zemli, no. 11, 1972, 3-7.

A generalized mathematical model of the power spectra of earthquakes is developed. A comparison is given between a power spectrum calculated using the developed model and a power spectrum determined from observed data.

The model of the power spectra of earthquakes originating in the crust, which can be expressed as q = q (T, k, r), where k = lgE(j), is considered. Assuming that the following relationships hold true,

$$\lg q = a_{T0} + a_{T1} \lg T + a_{T2} (\lg T)^2 + \ldots$$

$$\lg q = a_{K0} + a_{K1} K + a_{K2} K^2 + \ldots$$

$$d\varepsilon = a_0 \frac{1}{r^{n+1}} e^{-\alpha r} d\omega,$$

$$\alpha = \frac{\theta}{cT} = \frac{\pi}{cT} \frac{1}{Q}$$

where n is a discrepancy factor, α is the absorption coefficient, ϑ is the absorption decrement, Q is the quality factor, and C is the velocity, the following expression is obtained:

$$\lg q = \sum_{i=0}^{l} \sum_{j=0}^{k} a_{ij}(K - K_0)^j [\lg T - \lg T_0]^i + n[\lg r_0 - \lg r] + \frac{\beta}{T}(r_0 - r)\lg e,$$

where $\beta = \alpha T = \vartheta / c = \pi / (cQ)$

The power spectra calculated by the formula derived are found to be in good agreement with those determined from observational data on 45 aftershocks of the 1966 Tashkent earthquakes with K = 5-11 and r = 2.4-10.4 km (see Fig. 1).

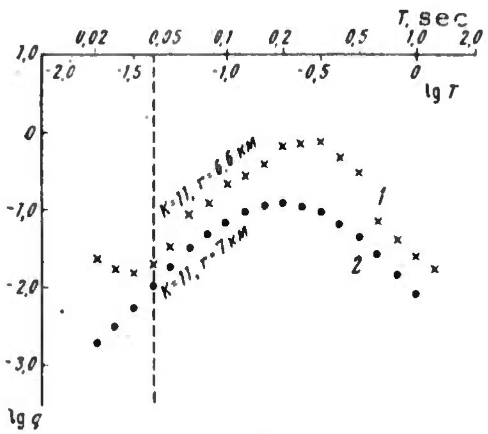

Fig. 1. Comparison of Observed (1) and Calculated (2) Power Spectra.

Kuzin, I. P. Velocity of P and S waves in the upper mantle of Kamchatka. IN: AN SSSR. Izvestiya. Fizika Zemli, no. 2, 1973, 3-16.

This article represents a continuation of an earlier article* on the velocity of seismic waves in the Kamchatka focal zone. It presents the results of a study of the velocity distribution in the mantle, within 40-50 km-wide zones adjacent to the Kamchatka focal zone on the continental and oceanic sides. Seismic wave velocities were determined from station discrepancies (anomalies) in the travel times of compressional and shear waves from earthquakes originating in the upper mantle. Data recorded at seven Kamchatka seismographic stations and the Bering Island station were used (see Fig. 1).

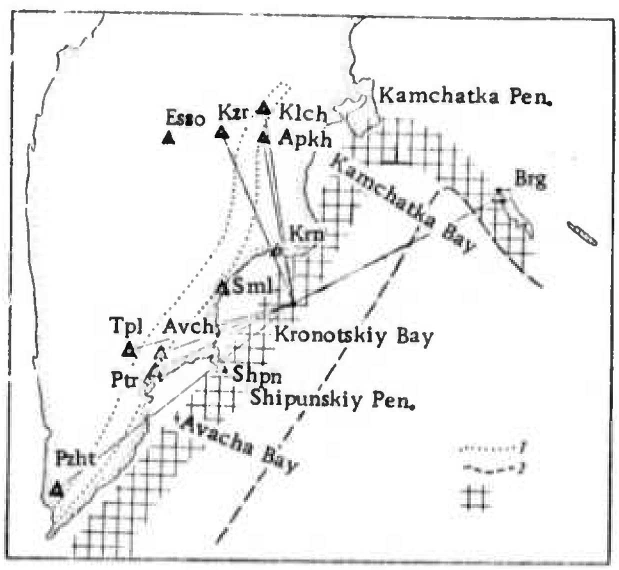

Fig. 1. Seismic Wave Trajectories Between the Earthquake Foci in Kronotskiy Bay and the Kamchatka and Bering Island Stations.

1 - East Kamchatka volcanic belt; 2 - axes of the Kurile-Kamchatka and Aleution trenches; 3 - emergence of the focal zones of Kamchatka and the Commander Islands onto the ocean bottom.

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* Velocities of the elastic waves in the Kamchatka focal zone. Kuzin, I. P. IN: AN SSSR. Izvestiya Fizika Zemli, no. 12, 1972, 25-39

The velocity of seismic waves in the upper mantle, within the regions adjacent to the Kamchatka focal zone, are found to be as follows:

Depth, km	Velocity, km/sec			
	Continental block		Oceanic block	
30-35 to 100	$V_P = 7.5\text{-}8.1$	$V_S = 4.4\text{-}4.6$	$V_P = 7.8$	$V_S = 4.5\text{-}4.9$
over 100	$V_P = 7.9\text{-}8.1$	$V_S = 4.5\text{-}4.6$	$V_P = 8.1\text{-}8.8$	$V_S = 4.6\text{-}5.0$

V_P and V_S velocities were estimated to have errors of ± 0.1 km/sec and less than ± 0.1 km/sec, respectively.

Besides the velocities in the mantle in the proximity of the focal zone, mantle velocities between the seismographic stations and the focal zone were also determined. The results are given in the table below which shows the average ray velocities in the mantle between the seismograph stations and the focal zone, from data on earthquakes originating in Kronotskiy bay.

Station	Depth interval for trajectories, km	Length of trajectories, km	V_P km/sec	V_S km/sec
Bering(Brg)	30-64	205	8.2	4.8
	30-110	332	7.9	4.6
Pauzhetka(Pzht)	35-64	187	7.5	4.4
	35-115	260	7.6	4.5
Petropavlovsk(Ptr)	35-70	129	7.8	4.5
	35-110	150	7.8	4.5
Avacha(Avch)	35-70	129	7.7	4.5
	35-110	150	7.6	4.4
Topolovo(Tpl)	35-70	129	7.8	4.5
	35-110	150	7.8	4.5
Klyuchi(Klch)	35-64	158	7.7	4.5
	35-100	150	7.8	4.5
Anakhonchich(Apkh)	35-64	158	7.8	4.5
	35-100	150	7.7	4.5
Kozyrevsk(Kzr)	35-64	158	7.7	4.5
	35-100	150	7.8	4.5

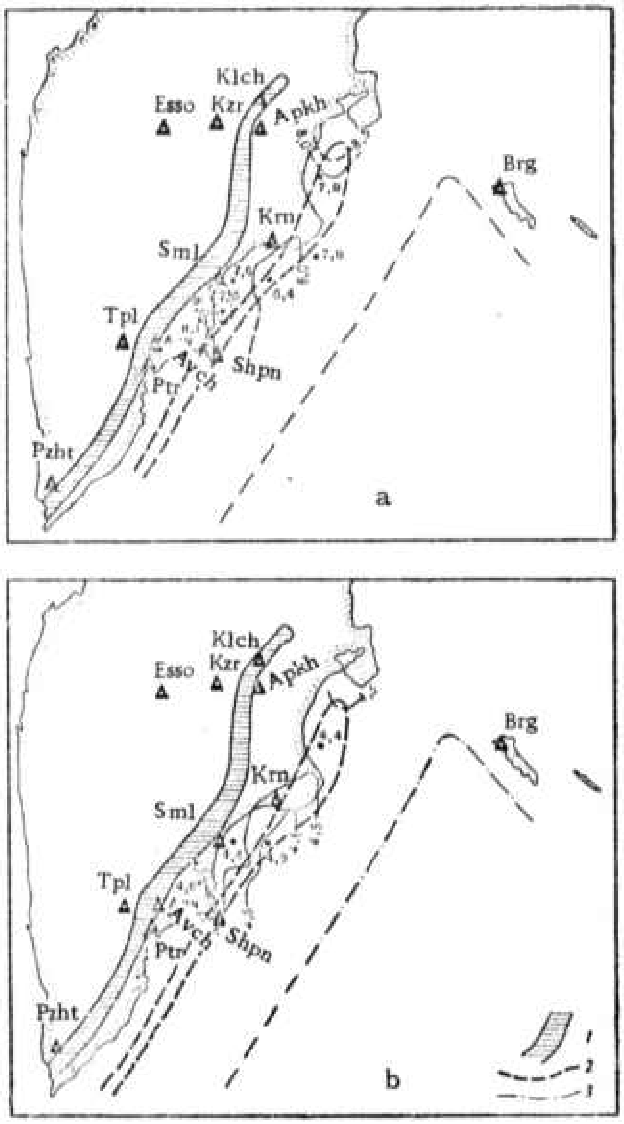
V_P and V_S velocities in the mantle between the seismographic stations and the focal zone were estimated to have errors of ±0.3 km/sec and ± 0.2 km/sec, respectively.

The present estimates of V_P and V_S in the mantle between the focal zone and seismographic stations are in good agreement with earlier estimate for the same region, as well as for the South Kurile region.

The distribution of the velocities of seismic waves in the Kamchatka focal zone and its environs is illustrated in the form of horizontal sections at depths of 60, 80, 100 and 120 km (see Figs. 2-5) and a composite transverse vertical section for the sector between the Shipunskiy and Kronotskiy peninsulas (Fig. 6).

The velocity distribution (see Figs. 2-6) to a depth of 100 km is very complex. The local areas of high and "normal" velocity form a mosaic-like pattern. Beginning from a depth of 100 km, the focal zone is more distinguishable with respect to its velocity. A sharp velocity discontinuity is observed between the focal zone and the adjacent continental block. The relationships between the velocities in the focal zone and those in the adjacent block are found to vary along the strike of the focal zone. In the Kronotskiy peninsula region the velocity in the focal zone is high relative to the velocity in the adjacent blocks; in Kronotskiy bay and Shipunskiy peninsula, the velocity has an intermediate value between the velocities in the continental and oceanic blocks. Local areas with high velocities are not found in the focal zone at depths over 100 km.

It is concluded that, to depths of 120 km, the focal zone cannot be a low velocity zone as suggested by Tarakanov and Yevyy, 1967. Neither is it a high velocity zone over the entire depth range as suggested by Oliver and Isacks, 1967. At depths to 60 km, the velocities in the focal zone represent intermediate values between the velocities in the continental and oceanic blocks. Only at depths of 60-120 km does the focal zone represent a high velocity zone separating continental and oceanic blocks with lower velocities.



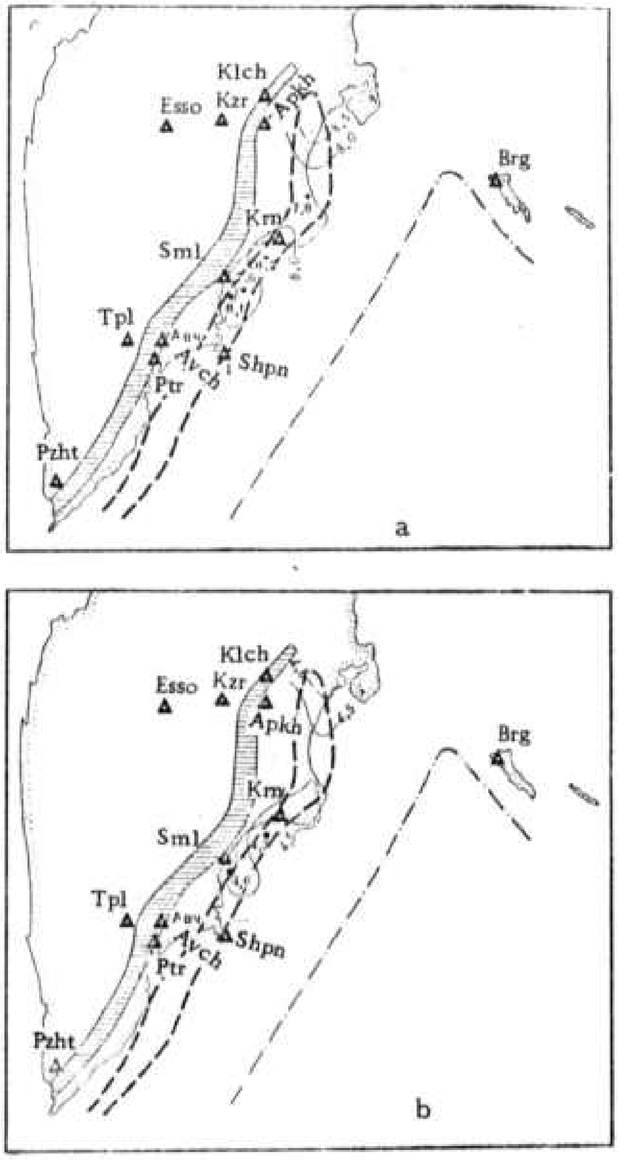


Fig. 2. Velocities V_P (a) and V_S (b) in the Mantle at a Depth of 60 Km.

1 - East Kamchtka volcanic belt; 2 - focal zone; 3 - axes of the Kurile-Kamchatka and Aleutian trenches

Fig. 3. Velocities V_P (a) and V_S (b) in the Mantle at a Depth of 80 Km.

(Designations same as Fig. 2)

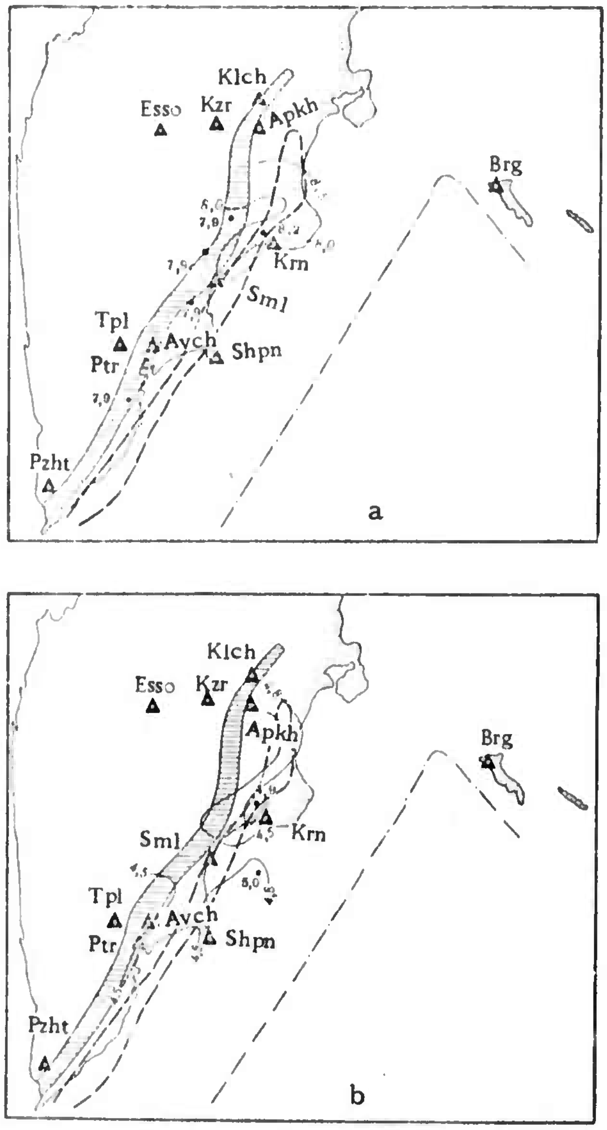


Fig. 4. Velocities V_P (a) and V_S (b) in the Mantle at a Depth of 100 Km.

(Designations same as Fig. 2).

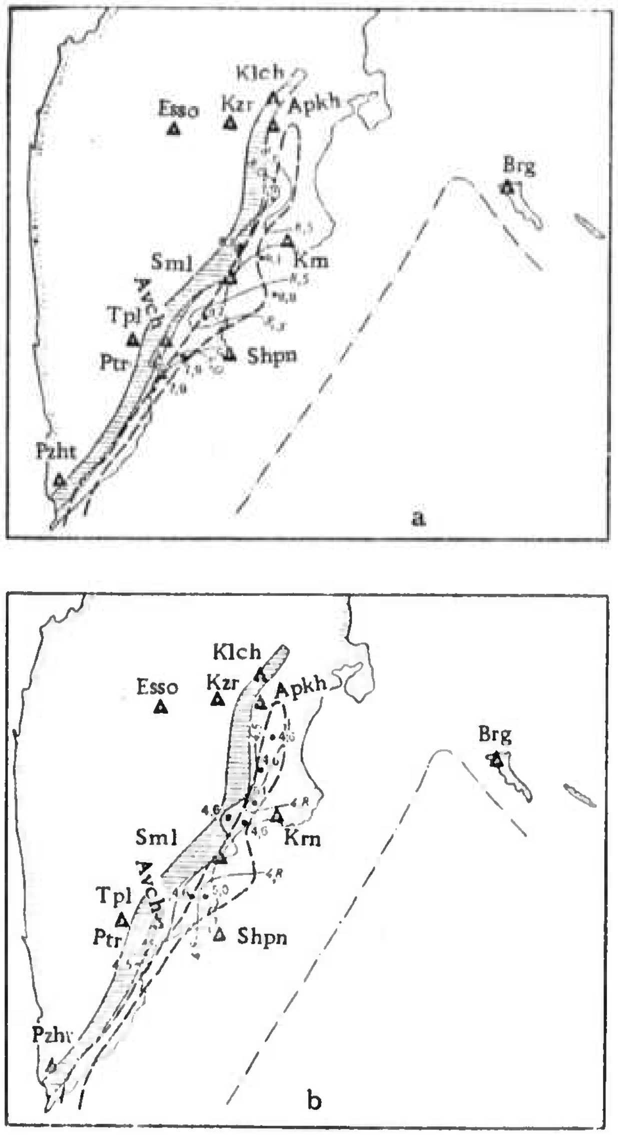


Fig. 5. Velocities V_P (a) and V_S (b) in the Mantle at a Depth of 120 Km.

(Designations same as Fig. 2).

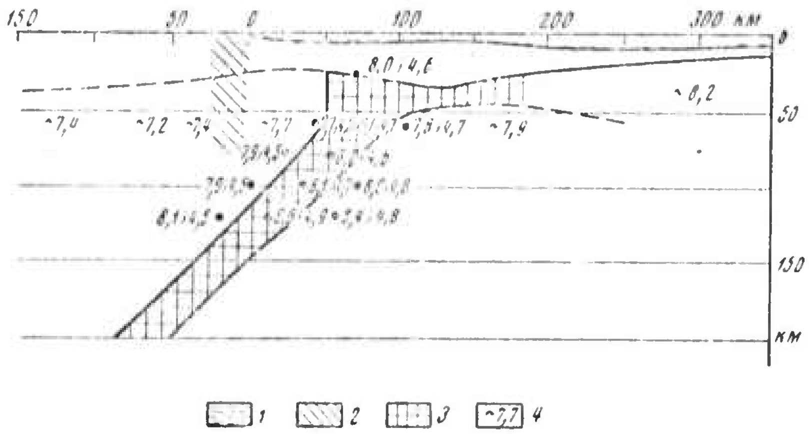


Fig. 6. Composite (Average) Vertical Velocity Section for the Focal Zone and Its Adjacent Regions between the Shipunskiy and Kronotskiy Peninsulas.

The section is perpendicular to the trend of the Kamchatka structures: 1- ocean; 2- East Kamchatka volcanic belt; 3- focal zone; 4- velocities according to Fedotov and Slavina, 1968.

Zhadin, V. V., and A. A. Dergachev. Estimation of the quality factor for the earth's crust, using records of microearthquakes. IN: AN SSSR. Izvestiya. Fizika Zemli, no. 2, 1973, 17-22.

A possibility is considered for the estimation of the quality factor Q for the crust from predominating periods of P and S waves from microearthquakes. Records of microearthquakes with hypocentral distances $\ell = 20 - 650$ km and $10^2 j < E < 10^{10} j$, were made in western Tuva and the Baykal rift zone using wide-bandpass seismic recording systems. The error in the estimation of Q due to neglecting the effect of the source energy is analyzed.

The estimation of the quality factor Q is based on the assumption that the predominant seismic-wave periods are equal to the periods corresponding to the maxima of their spectra. The observed apparent periods ranged from 0.012 to 0.75 sec (reading accuracy 0.01 sec).

The estimated values of quality factor Q are given in Figure 1. The Q values estimated from earthquakes with ℓ = 20-50 km (by formula

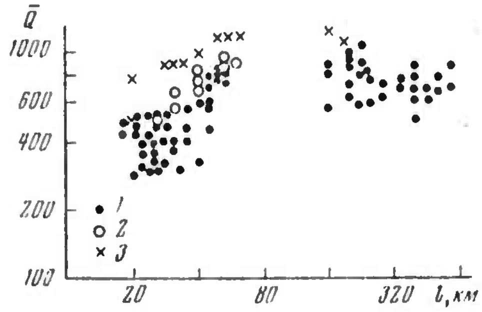


Fig. 1. Plot of Average Values of Q Estimated from from the Records of Seismic Shear Waves.

1- Western Tuva; 2- Ol'khon Island; 3- Shore of Baykal Lake.

$Q = \ell\omega_m/2c$) are characterized by a homogeneous distribution. They range from 300-500 in the western Tuva, and from 600-900 in the Baykal rift zone. The Q values estimated from earthquakes with ℓ = 150-650 km (by formula $Q = \ell\omega_m/4c$ have a normal distribution. The average value of the quality factor for western Tuva is estimated to be 700±100 and for the Baykal rift zone, more than 1000. It is concluded that the possibility exists for the estimation of Q factor by the method considered. The average value of the Q factor over a 500-1000 km-wide area can be estimated with a relative error of 15-20%.

Lin'kov, Ye. M., et al. Results of a study on seismometer zero-point drift. IN: Leningradskiy universitet. Uchenyye zapiski, no. 366, 1972, 201-223.

An analysis is given of observations of the zero-point drift of SVKD and SVK seismometers located in Leningrad and Moscow, respectively. and carried out during 1965 and 1968. Relationships are considered between the zero point drift of seismometers and: a) weather conditions; b) zero drift of gravimeter located in Alma-Ata; c) solar activity; d) magnetic activity; e) the rate of the rotation of the Earth; and f) seismic activity, and g) sea—level fluctuations.

The apparent periods of the fluctuation of the zero drift of seismometers $x_c(t)$, where x_c is displacement of the pendulum oscillation center, vary from several days to a month or more (see Figs 1a, b, and c). The amplitude spectra of the observed $x_c(t)$ are characterized by stable spectral composition (see Fig. 1 d). The $x_c(t)$ values are found to be uncorrelated with fluctuations of atmospheric pressure P(t) and the water level in the Neva river h'(t) (for the values of the corresponding correlation functions $r_p(\tau)$ and $r_{h'}(\tau)$ see Table 1). On the other hand, the values were found to be correlated with the fluctuation of the zero drift of a gravimeter g(t), as shown in Figs. 2 (for correlation function $r_g(\tau)$ see Table 1). It is concluded that the fluctuations of the zero drift of seismometers have a planetary origin.

Assuming that the fluctuations of seismometer zero drift are associated with the drift of the Earth, the correlation between solar and magnetic activities and Earth drift is analyzed.

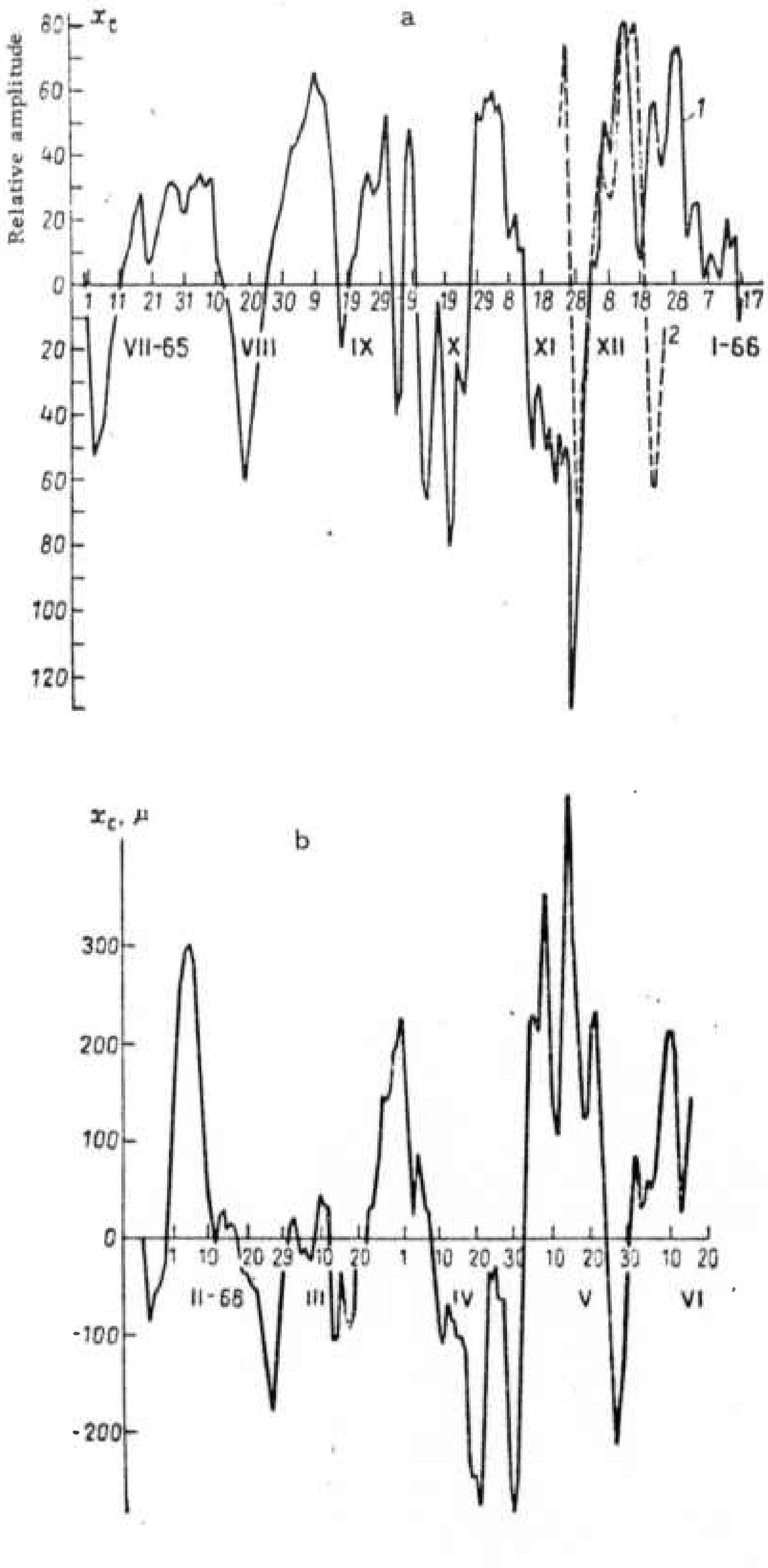


Fig. 1. Zero-Point Drift of Seismometers and Their Spectra.

a - 1965 (solid line - Leningrad; dotted line - Moscow);
b - 24 January - 15 June 1968.

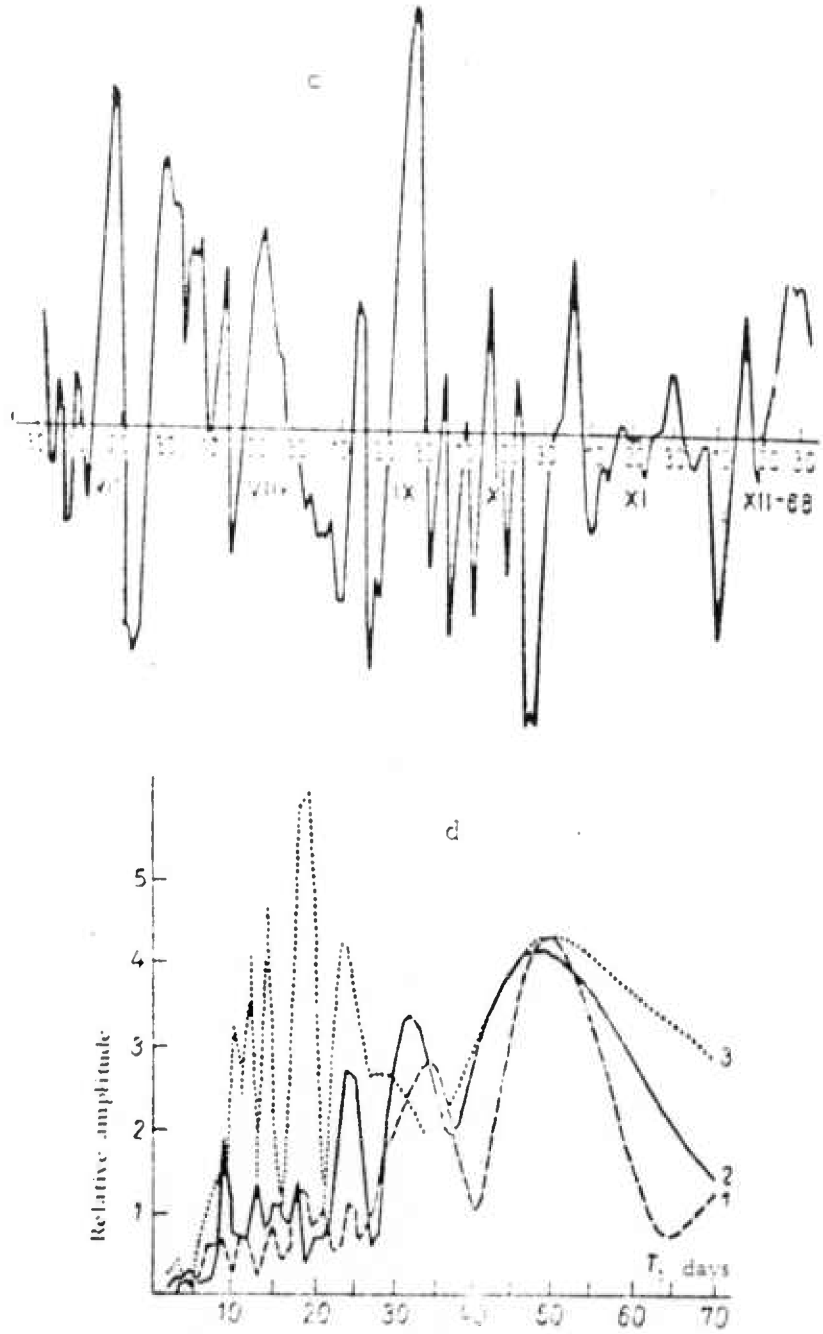


Fig. 1 (con't). Zero-Point Drift of Seismometers and Their Spectra.

c - 1 July - 31 December 1968; d - spectra of zero-point drift curves (1- 1 July 1965 - 20 January 1966; 2 and 3 - January - June 1968 and July - December 1968, resp.).

TABLE 1

τ (in days)	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6
$r_p(\tau)$	-	-	-	0.05	0.04	-0.02	-0.06	-0.01	0.08	0.14	0.15	0.13	0.10
$r_{h'}(\tau)$	-	-	-	0.10	0.00	-0.07	-0.05	-0.02	0.06	0.17	0.20	0.17	0.13
$r_g(\tau)$	0.66	0.70	0.72	0.73	0.74	0.75	0.72	0.68	0.65	-	-	-	-
$r_w(\tau)$ for 1965	0.54	0.60	0.61	0.57	0.50	0.39	0.27	0.17	0.08	-	-	-	-
$r_w(\tau)$ for 1968	0.50	0.55	0.59	0.61	0.62	0.60	0.56	0.51	0.46	-	-	-	-
$r_1(\tau)$	0.42	0.49	0.55	0.58	0.60	0.59	0.56	0.52	0.46	-	-	-	-
$r_{k_p}(\tau)$	-	0.33	0.40	0.46	0.52	0.57	0.61	0.62	0.62	0.50	0.56	0.51	-

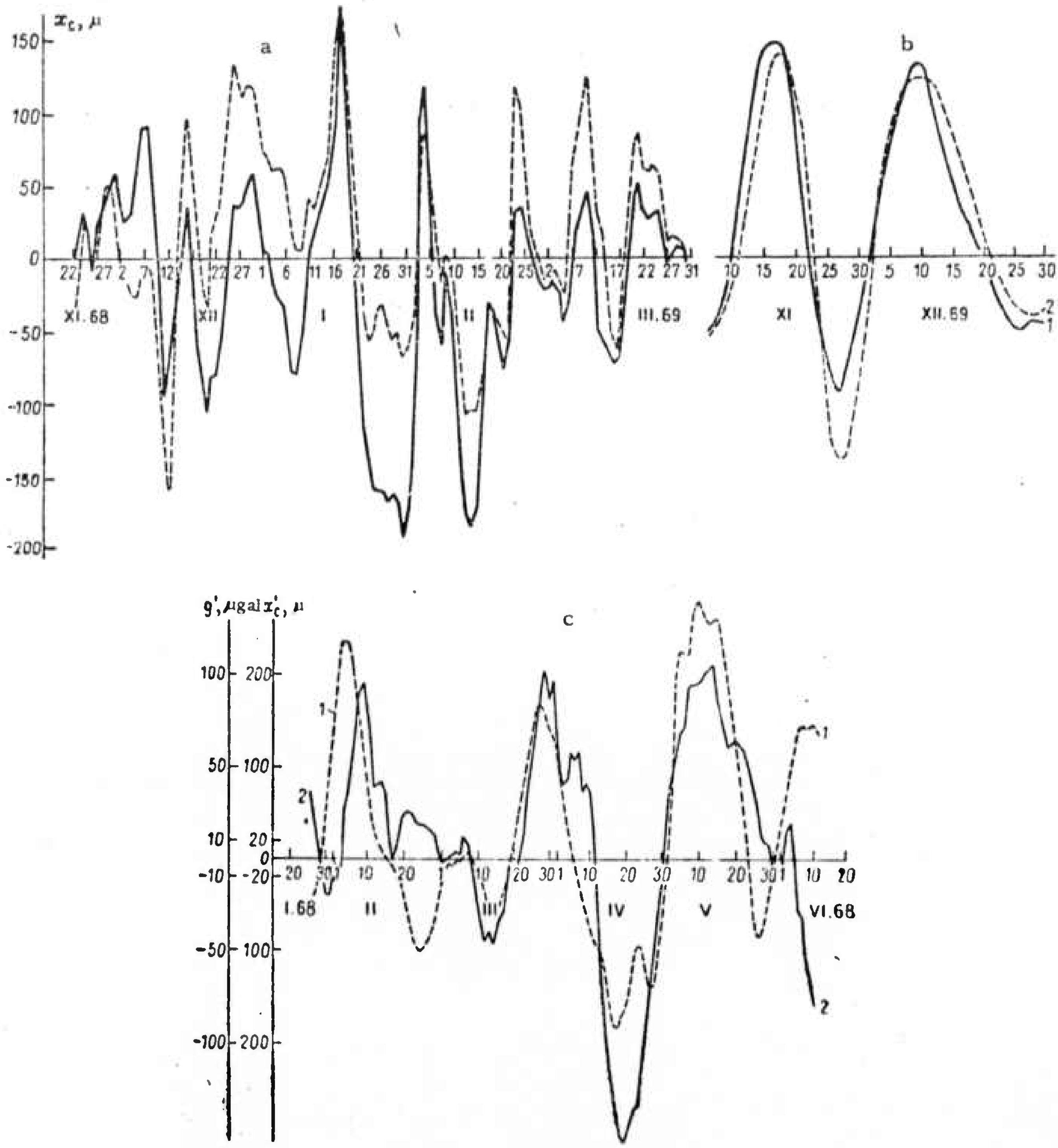


Fig. 2. Seismometer and Gravimeter Zero-Point Drift.

a - SVKD seismometer (solid line) and SVK seismometer (dotted line);
b - SVKD in Leningrad (1) and Pulkovo (2); c - SVKD (1) and gravimeter (2).

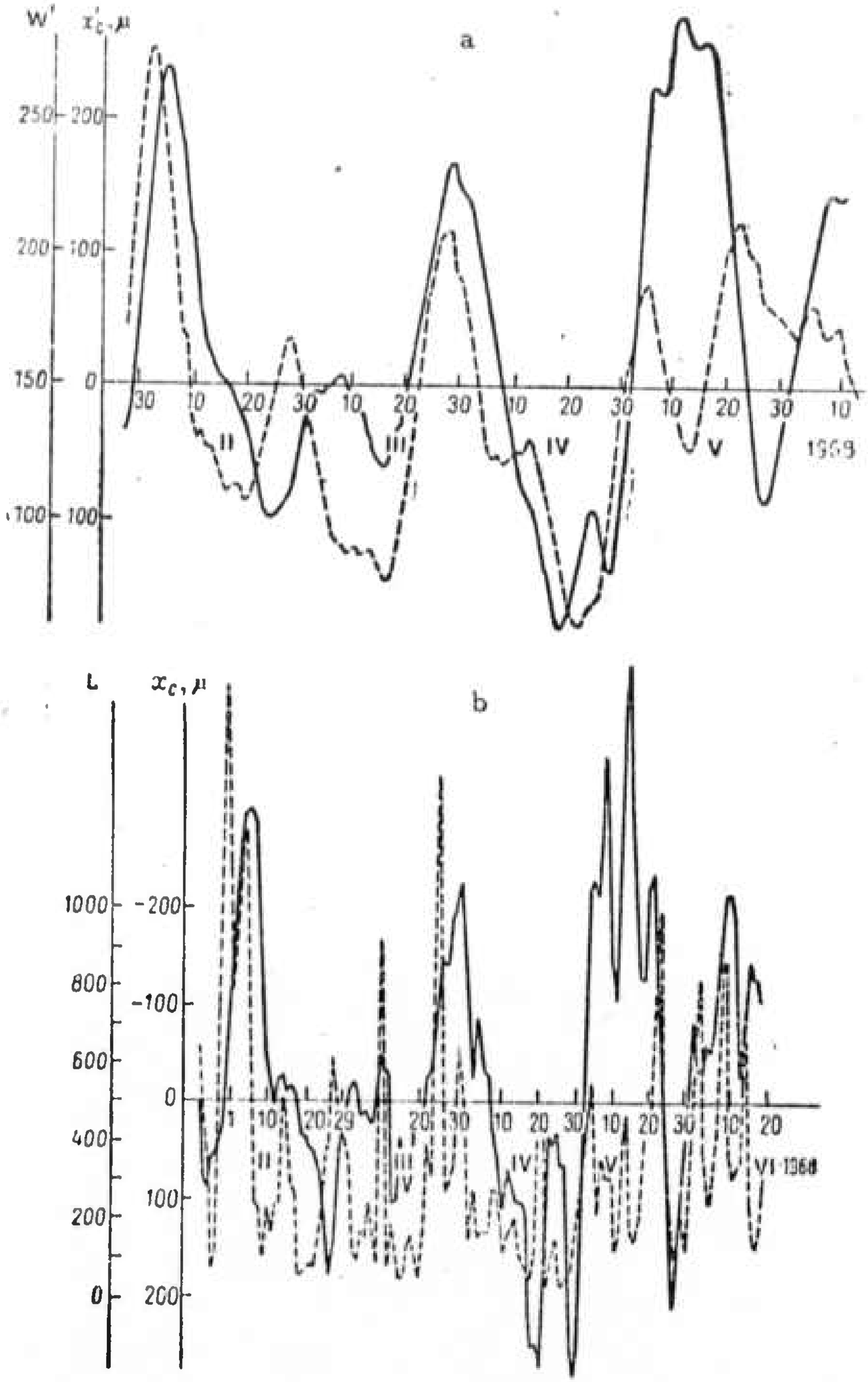


Fig. 3. Comparison of Seismometer Zero-Point Drift with Solar Activity (a and b); Solid line - seismometer drift; dotted line - solar activity.

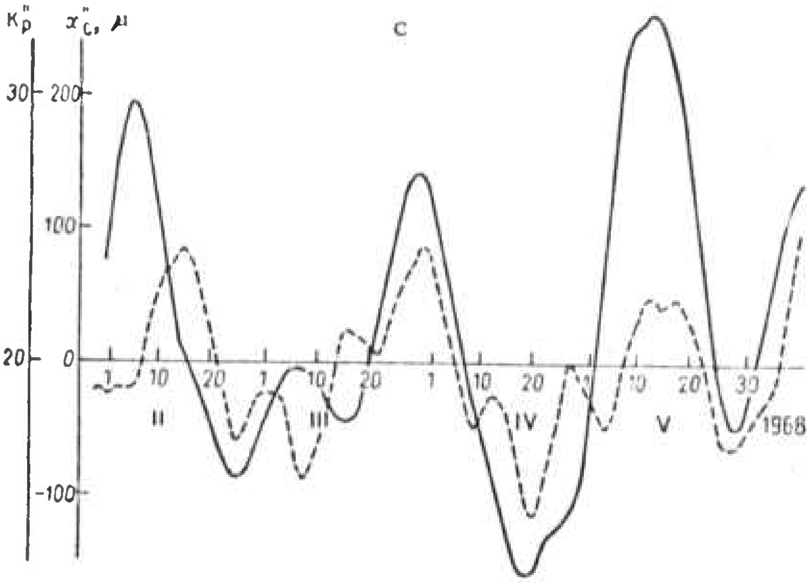


Fig. 3 (con't). Comparison of Seismometer Zero-Point Drift with Magnetic Activity (c); Solid line - seismometer drift, dotted line - magnetic activity.

The $x_c(t)$ values are found to be correlated with fluctuations of the parameters of solar activity (W and L numbers) and magnetic activity (K_p-index). W(t), L(t) and $K_p(t)$ curves are shown in Figures 3a, b, and c, respectively. The values of the corresponding correlation functions $r_W(\tau)$, $r_L(\tau)$ and $r_{K_p}(\tau)$ are given in Table. 1. Fluctuations in zero-point drift were preceded by fluctuations in solar activity by 4-5 days in 1965 and by 2 days in 1968, and were cophased with fluctuations of magnetic activity.

The correlation is analyzed between $x_c(t)$ and the fluctuations of the mean diurnal sea level observed at three gaging stations in the Arctic Ocean (80°37′N 58°03E; 76°16′N 94°46′E; and 76°57′N 68°33E) and at one in the Indian Ocean (67°39′S 45°50′E) Here $x_c(t)$ is found to be cophased with the fluctuations of the sea level in the northern hemisphere and antiphased with those in the southern hemisphere (see Fig. 4).

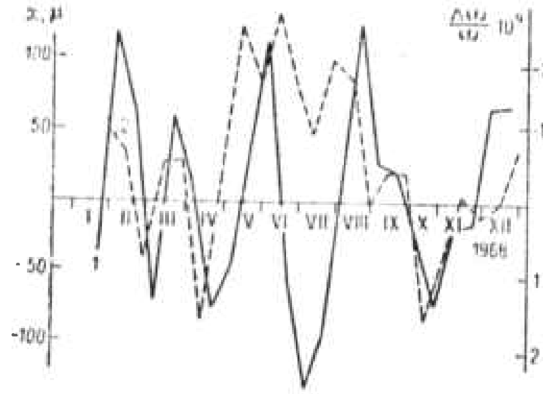


Fig. 4. Comparison of Zero-Point Drift
with the Earth's Rotation Rate.

This is in agreement with theoretical calculations of the deformation of the ocean surface due to Earth drift as presented in the article. The maximum values of the correlation function are -0.3 for the northern hemisphere and + 0.5 for the southern. Furthermore, seismometer zero drift is found to be correlated with fluctuations of the Earth's rotation rate. The corresponding correlation coefficient is 0.41. The fluctuations of the Earth's rotation rate lags 5-10 days behind fluctuations of zero drift (see Fig. 4). Continental drift corresponding to the observed fluctuations of the Earth's rotation rate is estimated to be $\ell = 105$ cm. The viscosity of the asthenosphere for which continental drift is possible, is estimated to be 10^{14} poise.

An analysis of the correlation between zero drift of seismometers and seismic activity shows that 70% of earthquakes with $M \geq 6.3$ coincide with peak values of zero drift or lag by $0.4\Delta t_z / \Delta t_e$ (see Figs. 5a and b) ($\Delta t_z / \Delta t_e = t_{o.e.} - t_o$) ($t_{z.e.} - t_{o.e.}$) where $t_{o.e.}$ is the time of the peak value preceding the origin time of an earthquake t_o, $t_{z.e.}$ is the time of the peak succeeding t_o). This result is explained as a consequence of the fact that zero drift represents fluctuations in the rate of the Earth's rotation.

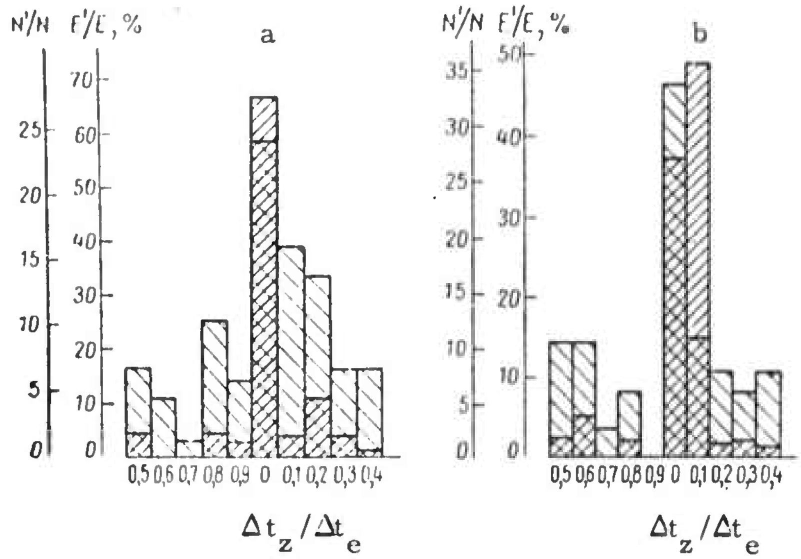


Fig. 5. Distribution of Relative Number (a) and Relative Energy (b) of Earthquakes with Respect to $\Delta t_z / \Delta t_e$.

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Vasil'yev, S. A. Some problems in the theory of the continuation of a wave field toward the source. IN: AN SSSR. Izvestiya. Fizika Zemli, no. 3, 1973, 35-47.

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Yaroshevskiy, G. A. Experience in recording shear and converted waves formed at interfaces in the crust. IN: AN SSSR. Institut fiziki Zemli. Seysmicheskiye svoystva granitsy Mokhorovichicha (Seismic properties of the Mohorovicic discontinuity). Moskva, Izd-vo Nauka, 1972, 80-90.

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Fedotov, S. A. Energeticheskaya klassifikatsiya Kurilo-Kamchatskikh zemletryaseniy i problema magnitud (Energy classification of Kurile-Kamchatka earthquakes and the magnitude problem). Moskva, Izd-vo Nauka, 1972, 115 p.

4. Particle Beams

A. Abstracts

Korolev, Ye. D., and P. A. Gavrilyuk.
Electron optical study of nanosecond discharges in air and carbon dioxide.
IVUZ Fiz., no. 11, 1972, 100-102.

Experimental observations are reported of discharge development sequences in air, nitrogen, and carbon dioxide. Discharge was initiated by an auxiliary spark gap in an apparatus similar to that described by Bugayev et al (ZhTF, no. 10, 1967). The emission photographs taken with 3-5 nsec per frame exposure and the oscilloscope traces of potential across the gap show consecutive discharge phases in air at atmospheric pressure and at various initial electron concentrations N_o, i.e. in nitrogen at p = 3,600 torr and high N_o, and in CO_2 at below atmospheric pressures and a high N_o. Low or high N_o was achieved by synchronization of the intensification pulse from the auxiliary spark gap with the main discharge pulse, or by delaying the former in relation to the latter. In air at a low N_o, the low-conductivity plasma channels jump the gap immediately before potential drop which occurs as the result of a sharp increase in current intensity through one of the channels. Transition to the high-conductivity channel is followed by the appearance of plasma with high N within the narrow channel and formation of discontinuous structure in the channel. In air at a high N_o, a characteristic step is observed on the oscilloscope trace, which greatly increases switching time. Potential drop is accompanied by diffuse emission from the electrode gap. A high-conductivity channel was not observed even after 15 nsec. from the onset of potential drop. Practically, all the stored energy is transferred to the gas discharge plasma over one pulse duration. The electron concentration in plasma attains $(10^{14}-10^{15})/cm^3$ and electron temperatue is 2-2.5 ev.

At p below atmospheric, diffuse discharge duration increases, e.g., to 40 nsec. at p = 300 torr and E = 60×10^3 v/cm. In nitrogen at a constant N_o the diffuse discharge duration decreases and step length also decreases to 1 nsec, when p is increased above atmospheric. A high-conductivity channel forms some 4 nsec. following switch start. In CO_2 at a high N_o and p = 740 torr, a step is observed on the oscilloscope trace and development of the high-conductivity phase is extremely slow, in comparison to that in air. At decreased p to 340 torr, the general trend is maintained toward an increase in volume of the conducting plasma.

Lominadze, D. G. Instability of a current-carrying plasma at cyclotron harmonics, and anomalous resistance. ZhETF, v. 63, no. 4, 1972, 1300-1311.

An instability theory is developed for a current-carrying plasma at electron cyclotron frequencies and their harmonics, and the nonlinear stages of this instability are studied. The anomalous resistance resulting from the cyclotron harmonic oscillations is determined. It is shown that the mechanism leading to oscillation saturation in the case of kinetic instability as well as hydrodynamic instability at $T_i \gtrsim T_e$, is electron instability. These unstable oscillations induce heavy electron scattering at turbulent electric field pulsations; the presence of an effective collision frequency can overcome the instability. At $T_e \gg T_i$, the effective collision frequency may not result in oscillation saturation, but in a decrease of the increment. The analysis of the nonlinear instability saturation problems considered here is based on an analogy between normal binary collisions and particle scattering at oscillations in an unstable plasma. Several hypothetical examples are presented of instability variants.

Rabinovich, M. I., and S. M. Faynshteyn. High-frequency instability of electromagnetic waves in a non-equilibrium magnetized plasma. ZhETF, v. 63, no. 5, 1972, 1672-1677.

The high-frequency instability of an e-m wave in a non-equilibrium plasma is analyzed from the point of view of interaction of high-frequency and low-frequency e-m waves with an intermediate frequency negative energy plasma wave. To establish the interaction of such waves, approximate initial equations for electric and magnetic fields and dispersion equations for the media are derived. Assuming that wave interactions satisfy synchronism conditions, solutions are obtained to the initial equations and a coefficient of nonlinear interaction established. On the basis of these derived relations the wave interaction is then analysed. It is shown that the most significant feature of the interaction is the possible low-frequency wave instability which leads to excitation of two high-frequency waves by means of low-frequency pumping. The mechanism of such an instability is discussed and its increment is determined. The theoretical results are applied to some examples using typical laboratory parameters.

Nedoseyev, S. L., V. P. Smirnov, A. M. Spektor, and D. G. Fil'kin. Effect of the plasma in an accelerator gap on relativistic electron beam current density. ZhTF, no. 12, 1972, 2520-2523.

A significant increase in current density of a relativistic electron beam has been detected in experiments with electron beam acceleration, using a diode whose interelectrode gap was filled with a plasma of

density nearly equal to that of the beam electrons. The experiments were carried out in the "Neptune" accelerator (Fig. 1) with a double linear pulse

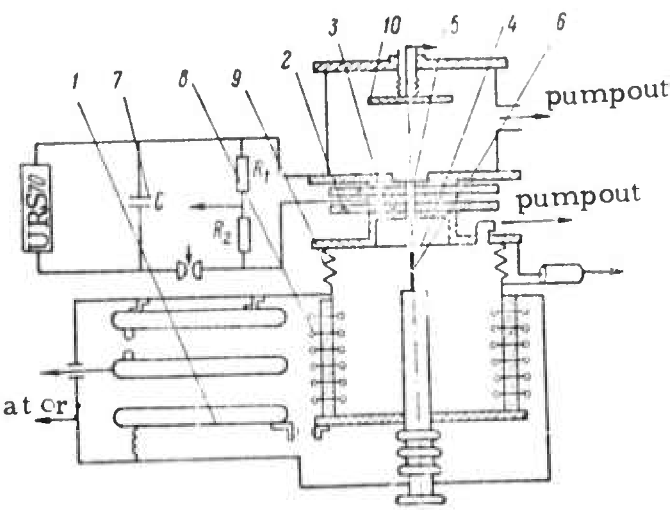

Fig. 1. Neptune accelerator with plasma-filled diode: 1- double linear pulse shaper, 2- plexiglass discs, 3- metallic electrodes of plasma source, 4- disc anode with an orifice, 5- tantalum foil, 6- cathode, 7- plasma-generating capacitor battery, 8- insulation of accelerator tube, 9- measuring shunt, 10- Faraday cage.

shaper which produced, under a matched load and 0.7 Mv potential, 40 nsec. current pulses. A vacuum or a plasma-filled diode acted as the load on the pulse shaper. In the latter case, a plasma jet was generated separately by discharge of a capacitor on the surface of a channel drilled through discs 2, and was collimated by the orifice in the anode 4. The plasma channel and the accelerator gap, about 8 mm long, were evacuated to 10^{-5} torr. Radial and axial plasma densities n were measured by Langmuir probes and current I across the diode was measured by the shunt and recorded oscilloscopically. The scope traces show a strong n-dependence of I and matching at $n = (2\text{-}3)\times10^{12}\ cm^{-3}$. The corresponding anodic current density j was $\approx 20\ kA/cm^2$ i.e., 10 to 15 times greater than j in a vacuum diode. The electron beam density n'_e was $\cong(3\text{-}4)\times10^{12}\ cm^3$. The pulse shaper-diode matching was attained at the ion concentration n_i in the gap equal to 1/2-1/3 of

n'_e. In this case, current intensity is limited by the electron space charge which is partly compensated by the ions.

Theoretically, at $n'_e = n_i$ current density as high as desired can be obtained without shortening the accelerator gap. Practically, however, density is limited by the voltage source power, current filament inductance, and instability of a compensated beam. Simple evaluation of data indicates that under the cited experimental conditions, the stored energy of turbulent plasma in which instability may be excited is converted to electron energy instead of being dissipated as heat. This conclusion is confirmed by observation of damage to the anode, which was characteristic of an intense electron beam. In the experiments described, a beam of relativistic electrons forms near the cathode, while plasma ions only insure a partial compensation of the electron space charge. In addition to the significant increase in beam density, the plasma-diode technique of beam acceleration may possibly simplify transport of intense electron beams to and injection into various experimental devices.

Kingsep, S. S., I. V. Novobrantsev, L. I. Rudakov, V. P. Smirnov, and A. M. Spektor. Mechanism of gas ionization by an intense electron beam. ZhETF, v. 63, no. 6, 1972, 2132-2138.

Experimental and a theoretical studies are presented on the mechanism of plasma formation by injection of a 660 kev beam of 10-20 kA intensity and 4×10^{-8} sec. duration into a neutral gas in a drift chamber. The effect of gas pressure $p \geq 10$ torr in the chamber on plasma concentration n_e and inverse current density σE was determined experimentally in air and He. In the experimental arrangement described (Fig. 1) intensity I_b of a relativistic electron beam from a "Neptune" accelerator was recorded

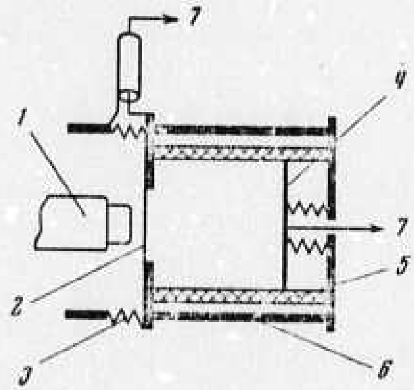

Fig. 1. Experimental arrangement:
1 - cathode, 2 - foil anode, 3 - shunt,
4 - collector, 5 - drift chamber, 6 -
metallic coupling studs, 7 - to oscilloscope.

by means of a shunt along the anode flange of the accelerating tube. Inverse current is excited in the dense plasma created by gas ionization due to secondary electrons at increased p. The p-dependence of I at $p \geq 1$ torr was determined with an 80 cm. drift gap (Fig. 2). The cited

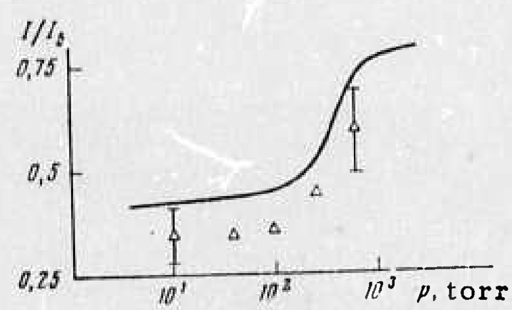

Fig. 2. I/I_b ratio versus the pressure,
Δ = experimental points.

experimental data were interpreted in terms of the Townsend approximation of a gas ionization mechanism, assuming that electric field E is induced by the sum of plasma and beam current. Time dependence of n_e, E, and current densities σE and $j_b + \sigma E$ was calculated and plotted for He and N at $p = 10^{-1}$ and 10^{-2} atm. and a beam of $I_b \cong 13$ kA. Qualitatively, theoretical dependencies coincided with the experimental. The presence of a pulse spike on the decay curve of j is a characteristic of the inverse current. The spike amplitude is practically independent of p, which explains the weak

p-dependence of I maximum at $p < 10^2$ torr. At higher p, the I(p) dependence is more pronounced. The $\sigma E/I_b$ ratio at maximum I_b increases, when p decreases, and at $p \cong 10$ torr, attains 0.85 and 0.6 for He and N, respectively. In summary, at a sufficiently low p, gas ionization by the beam-induced electric field predominates over ionization by fast electrons of the beam. The former ionization mechanism interferes in the readily ionized gases, e.g., He, at a higher p than in a relatively unionizable gas, e.g., nitrogen.

Rogashkova, A. I., M. B. Tseytlin, I. F. Kharchenko, and I. T. Tsitson'. <u>Analysis of the change of distribution function with electron velocity in a beam during interaction with plasma</u>. ZhTF, no. 1, 1973, 95-100.

Nonlinear interaction is analyzed of a velocity-modulated electron beam with longitudinal waves in a plasma waveguide. A set of nonlinear equations describes development of oscillations in a cylindrical waveguide, which is assumed to be completely filled with isotropic plasma interacting with the electron beam. Numerical solution of the cited equations gives exhaustive information on spatial development of instability in the beam-plasma system. Some results of numerical integration of the cited equations are given in the case of initial modulation at the fundamental frequency. Amplitudes $I_{1,2}$ of the first two harmonics of HF current versus distance ξ from the entrance to the system are calculated and plotted for the parameters ω_p^2/ω^2 and Γ_1 = 1.6 and -1.8, 1.1 and -10, 3.5 and -0.4, where ω_p and ω are the frequencies of plasma electrons and modulation potential, respectively, and $\Gamma_{1,2}$ are the coefficients of depression of the Coulomb field at the ω, 2ω frequencies. Analogous plots were calculated

for a klystron. Comparison shows that in the first case interaction of electrons with the induced charges in plasma results in an increased I_1 and a decreased effective drift. In that case, I_1 oscillations, after the first peak, are nearly periodical, while in the case of $\omega \approx \omega p$ the $I_{1,2}$ (ξ) is irregular. In the third case ($\Gamma_1 = -0.4$, $\Gamma_2 = 8$), I_1 increases up to the first peak and effective drift decreases, in comparison to a klystron.

In the most interesting case of $\omega \approx \omega p$, the velocity-distribution function of electrons is plotted for different ξ (Fig. 1a).

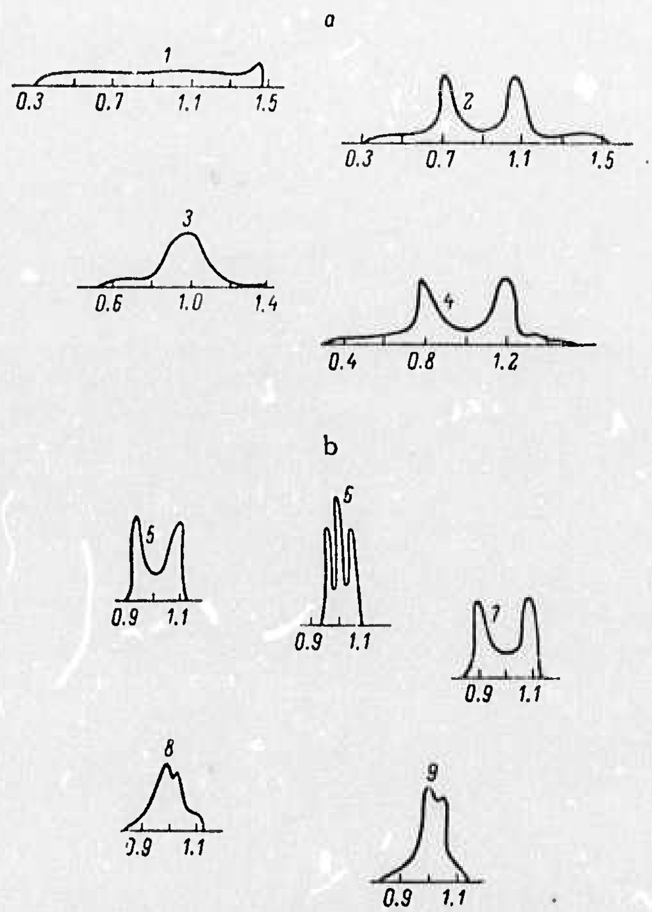

Fig. 1. Velocity distribution function of electrons versus distance ξ = 8(1), 15(2), 105 (3), 110(4), 6(5), 14(6), 32(7), 75(8), and 90(9); a) ω_{pe}^2/ω^2 = 1.1; b) beam in vacuum. Parameters ω_{pe}^2/ω^2 = 0.01, α = 0.1, where ω_{pe} is the frequency of beam electrons in plasma and α is the coefficient of initial modulation.

In this case the distribution function exhibits one or more peaks. The function is maxwellian in the points of I minima, but it presents a double-hump curve in the points of I maxima, where the electrons are bunched. The average beam velocity remains constant. The comparable function for a klystron (Fig. 1b) exhibits three peaks in the region of the first bunch. At a greater ξ the bulk of electrons acquire velocities within a narrower range than the initial distribution, in contrast to the plasma. Near resonance ($\omega \approx \omega_p$), the electron motion becomes more turbulent. This is shown by the change in pattern of the electron velocity v(t) in different regions of interaction.

Bondarenko, G. G., and L. I. Ivanov.
Effect of electron irradiation on the structure and mechanical properties of aluminum.
FiKhOM, no. 6, 1972, 47-50.

The effects of 2.3 Mev electron irradiation on the mechanical properties and polycrystalline structure of aluminum with 99.9 and 99.99% purity levels were experimentally investigated at room temperatures. The test specimens were of flat 50 μ Al, annealed in a vacuum chamber for 2 hrs. at 580^{o} C. Mechanical properties were determined from test results and tabulated for several specimens. The radiation intensity was 1×10^{14} el/cm^{2}sec and the radiation dosage was (2.5 - 7.2) 10^{18} el/cm^2. The irradiation temperature was maintained constant by a thin film of water on the specimen surface and was controlled by thermocouples. An electron-microscopic analysis of surface effects was made with a resolution of at least 40 Å. Test results show significant changes of mechanical properties in the 99.9% pure Al specimens whereas in the 99.99% pure specimens the electron irradiation effects were negligible. The changes in the 99.9% pure specimens are associated with the development of point defect accumulations, which acted

as buffers for dislocation movements. The density of these accumulations increases linearly with radiation dosage increment (Fig. 1); and with an increase of radiation intensity at a constant integral dose, as illustrated in Fig. 2.

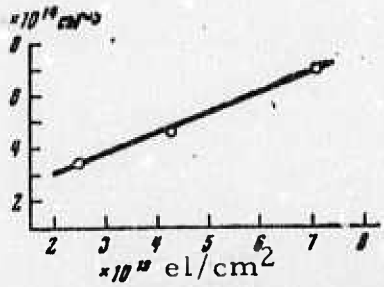

Fig. 1. Accumulation density in irradiated specimens as a function of radiation dosage.

Fig. 2. Defect accumulations, formed in aluminum by electron irradiation.

(a) - Dose = 7.2×10^{18} el/cm^2, intensity = 10^{14} el/cm^2/sec (x50,000)
(b) - dose = 7.2×10^{18} el/cm^2, intensity 5.6×10^{14} el/cm^2/sec (x30,000)

Krivitskiy, Ye. V. Study of channel resistance in an underwater spark discharge. ZhTF, no. 11, 1972, 2362-2365.

A single oscillatory circuit equation and solution of the previously derived equation of energy balance (ZhTF, v. 42, no. 1, 1972, 83) are used to express underwater current i in the discharge circuit as a

function of discharge parameters C and L. The energy balance in the form of a Bernoulli equation is solved for the variable active resistance R in the discharge channel. At a constant rate of channel expansion (linear time-dependence of its radius a), the solution is given by

$$\left(\frac{R}{l}\right)^2 = \frac{A}{2} \frac{t^{4(\gamma-1)}}{\int_0^t i^2 t^{4(\gamma-1)} dt} \tag{1}$$

where l is the channel length, γ is the adiabatic exponent of channel plasma, and A is a spark constant. In the more general case where $a = \beta t^{\alpha}$, in which α and β are constants, the solution for R becomes

$$\left(\frac{R}{l}\right)^2 = \frac{A}{2} \frac{t^{4\alpha(\gamma-1)}}{\int_0^t i^2 t^{4\alpha(\gamma-1)} dt} \tag{2}$$

Eq. (2) was used to derive a differential equation in one dependent variable i, on the assumption that A = const. during the discharge. Simultaneous variations in the magnitude of A and temperature T during the discharge were estimated for given discharge characteristics. A was calculated from the experimental i, R, and a values within a short time interval and from the plasma characteristics from three different sources. Both methods gave approximately constant A values during the first discharge half-period; typically $A \cong 0.25 \times 10^5 V^2 \times sec/m^2$. The estimated T during the same period was over 1.5×10^4 °K. For given discharge characteristics, T decreases to $(1.1-1.3) \times 10^4$ deg. K during the first quarter-period (to 40 μsec). The end of this period coincides with deviation in A from its constant value. Thus the lower limit of applicability of (1) and (2) is determined to be $T = 1.2 \times 10^4$ °K. A fourfold greater value has to be assigned to A in (1) and (2) to allow for the discrepancy between l of the channel and the electrode gap, if breakdown is initiated by a high-voltage discharge. Thus limits are established for an exact determination of R as a function of i by control of the oscillatory circuit. The described method is applicable to most actual discharge regimes.

Rakovskiy, G. B. Solution of an equation for a circuit transient process from a pulsed discharge in water. ZhTF, no. 9, 1972, 1982-1986.

Expressions defining an underwater spark discharge are derived and discussed. The equation of the transient process is solved analytically under the assumption that resistance of the channel varies according to the curve of Fig. 1, based on experimental data.

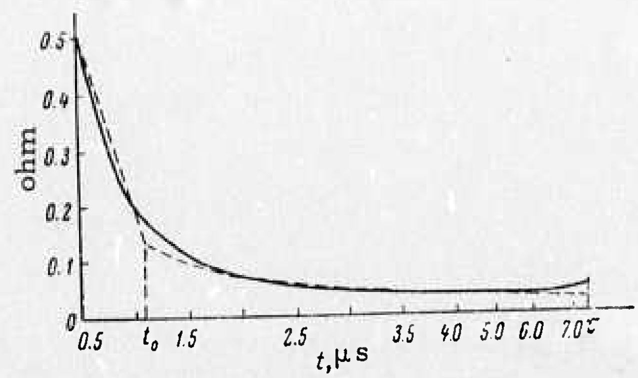

Fig. 1. Dependence of channel resistance on time during the first half-period of current. Discharge parameters: C = 3.22 μf, L = 1.86 μh, U_o = 44 kv, ℓ = 20 mm.

Two portions can be distinguished: a linear segment of resistance drop ($o<t\leq t_o$) and the hyperbolic portion ($t_o<t<\tau$). In view of the observed variation characteristic it is proposed to solve the equation of the transient process for each portion separately. For the first portion we have:

$$r(t) = r_0 - \alpha t, \tag{1}$$

and for the second,

$$r(t) = \frac{\gamma}{t}. \qquad (2)$$

where r_0, α and γ are constants for a given process depending on the parameters of the discharge circuit. In these two cases the integro-differential equation

$$L\frac{di}{dt} + \frac{1}{C}\int_0^t idt + ir = U_0 \qquad (3)$$

is solved. In the first case, by introducing dimensionless variables, Eq. (3) is reduced to a linear second order differential equation, which was integrated by means of a power series using the method of indeterminate coefficients. In the second case the transient process equation reduces to a second-order nonlinear differential equation similar to the Bessel equation. Solution of this equation is obtained in terms of first-kind Bessel functions. Comparison of theoretical results with experiment shows that the approximations used are acceptable. Significant errors arise only at the boundary of a half-period; otherwise the solutions obtained adequately describe the character of the voltage and current variation in the first half-period, and also the character of current attenuation during the entire discharge process.

Bugayev, S. P., A. S. Yel'chaninov, and F. Ya. Zagulov. Pulsed plasma source of electrons. Otkr izobr, no. 33, 1972, no. 341417.

A pulsed plasma source of electrons is proposed, consisting of a cathode, composed of several dischargers with a common electrode connected to a high voltage pulse generator; and a grounded metal foil or grid extractor. To increase the output current amplitude, conductance rise, and stability, the capacitance ratio of the divider arm (formed from the interelectrode capacitance of the discharger and the capacitance between the discharger electrode which is not connected to the generator and ground) is selected to be substantially less than unity.

Rutberg, F. G., B. P. Levchenko, and V. S. Borodin. High power pulsed plasmatron. IN: Sbornik. Tezisy dokladov V Vsesoyuznoy konferentsii po generatoram nizkotemperaturnoy plazmy. Novosibirsk, v. 2, 1972, 100-102. (RZhMekh, 12/72, no. 12B102)(Translation)

Problems in developing powerful plasma generators are discussed. Data are presented for generators with the following maximum parameters: power -8.5x10^8 w; energy -10^6 joules; pressure-1000 atm; gas temperature 2x10^{4o} K, and discharge electron density 4x10^{19}cm^{-3}.

Grishin, V. K., and A. A. Kolomenskiy.
<u>On stability of relativistic beams in a medium</u>. KSpF, no. 6, 1972, 49-52.

The stability of confined charged beams propagating in a plasma within a strong longitudinal magnetic field has been studied in a series of articles without taking into account the effect of the self-magnetic field of the beam. The present authors analyze the conditions under which the effect of the beam self-magnetic field upon the stability of relativistic beams in plasma medium cannot be neglected. For simplicity the case is assumed of a beam and plasma with constant density, filling a waveguide of infinite length and rectangular cross-section. The equations of the beam electric field are derived from which the dispersion equation describing the character of longitudinal beam oscillations, and the equation describing e-m wave behavior in the beam, are derived. On the basis of these expressions, frequency intervals are established in which electromagnetic oscillations in the beams are unstable under certain conditions; these conditions are satisfied when plasma density attains some critical value. Analysis of the results shows that a new form of instability (Buneman instability) arises in a relativistic beam when the self-magnetic field of the beam is taken into account. The results obtained have only a weak dependence on the form of the waveguide cross-section, and are also not materially affected if there is a small gap between the beam and the waveguide walls.

The same general topic has been treated earlier by Grishin (cf. March 1972 report, p. 104).

Ivanov, A. A., V. V. Parail and T. K. Soboleva. Nonlinear interaction theory of a monoenergetic beam with a dense plasma. ZhETF, v. 63, no. 5, 1972, 1678-1685.

The interaction of a monoenergetic beam of electrons with a collision-type dense plasma is analyzed, and it is established that the linear phase of interaction is unstable. Furthermore, with increase in oscillation amplitude, the beam-plasma interaction process becomes nonlinear and cannot be described analytically. Hence for solution of this problem the method of partial numerical simulation is applied.

The interaction of a one-dimensional monoenergetic electron beam with a collision plasma is analyzed first for the case when only one wave is excited in the plasma. A set of equations describing the interaction is derived, based on motion, continuity and Poisson equations. This system was solved by the Runge-Kutta method on a computer; some characteristics of th numerical solution are also described. Graphical solutions of several hypothetical interaction cases are presented. The authors stress that the foregoing model cannot present an exact picture of the interaction instability, since in the actual interaction of an electron beam with plasma, not one, but many waves are excited in the plasma. A system of equations describing the behavior of the plasma-beam system, for the case where more than one wave is excited, is obtained by the method described above together with certain modifications. The time dependences of wave energy for five harmonics is also graphically represented. The results indicate that the nonlinear interaction phase is characterized by the appearance of thermal spread in the initially monoenergetic beam, which prevents the development of instability and makes it possible for the beam to traverse the plasma without any significant energy losses.

Matevosyan, G. G. Angular dependence of polarized energy loss from heavy charged particles in a plasma located in a high-frequency electric field. KSpF, no. 7, 1972, 13-16.

Polarized energy losses of charged particles moving in plasma at an arbitrary angle θ to the high-frequency electric field vector are analyzed. The author assumes that the particle is sufficiently heavy and its oscillatory motion imparted by the high-frequency field can be neglected. The energy losses of charged particles are determined in terms of the braking force of the plasma electric field acting upon the particle. A general expression for losses W derived earlier, is given. Taking into account the transparency regions of plasma and assuming that the distribution function of electrons is Maxwellian, the author obtains the final form for W as a function of angle θ. The study is limited to the case of weak electric fields when the velocity of a charged particle $\vec{u}$ is larger than the velocity of oscillations of electrons $\vec{v}_E$ in high-frequency electric field ($\vec{u}/\vec{v}_E > 1$). The dependence of polarized energy losses W on θ is analyzed and it is established that at $0 \le \theta \le \mathrm{arctg}\sqrt{2}$ the energy losses owing to the high-frequency electric field increase, and at $\mathrm{arctg}\sqrt{2} \le \theta < \pi/2$ the energy losses decrease.

B. Recent Selections

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Kuppers, G., A. Salat, and N. K. Wimmel. Makroskopicheskoye ravnovesiye relyativistskikh elektronnykh puchkov v plazme. (Macroscopic equilibrium of relativistic electron beams in plasma). IPP-Ber., no. 6/110, 1972, 30 p. (RZhF, 2/73, no. 2G303)

Kuppers, G., A. Salat, and N. K. Wimmel. Tok i polya, indutsiruyemyye v plazme relyativistskim elektronnym puchkom s proizvol'nym radial'nym i aksial'nym profilem plotnosti. (Currents and fields induced in plasma by relativistic electron beams with arbitrary radial and axial density profiles). IPP-Ber., no. 6/110, 1972, 24 p. (RZhF, 2/73, no. 2G291).

Matevosyan, G. G. Angular dependence of polarized energy loss from heavy charged particles in a plasma located in a high frequency electric field. KSpF, no. 7, 1972, 13-16.

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5. Material Sciences

A. Abstracts

Zarubina, O. A. Superconductivity of lanthanum at pressures to 250 kbar. FTT, no. 10, 1972, 2890-2893.

An investigation is made of the relationship of the transition temperature T_c of lanthanum into the superconductive state to pressure P, over the pressure range from 0 to 250 kbar. Two methods were used for creating pressure: 1) by means of an "ice" multiplier, whereby measurements could be conducted at a specific pressure for a given specimen; in this case, changing the pressure required refitting of the high-pressure chamber and replacement of the specimen; 2) a method by means of which the same specimen could be studied at different pressures. For this purpose, anvils were compressed at room temperature in a mechanical press, and the created force was immobilized. In the succeeding experiments, the value of the force could be increased without dismantling the high-pressure chamber.

It was observed that a large increase of T_c with pressure is interrupted by a change in the slope of the $T_c(P)$ curve in the region of $P \cong 70$ kbar; within the pressure range of 100-250 kbar, T_c virtually ceases to be a function of the pressure. Figs. 1 and 2 illustrate the results. The findings are discussed in terms of existing theory.

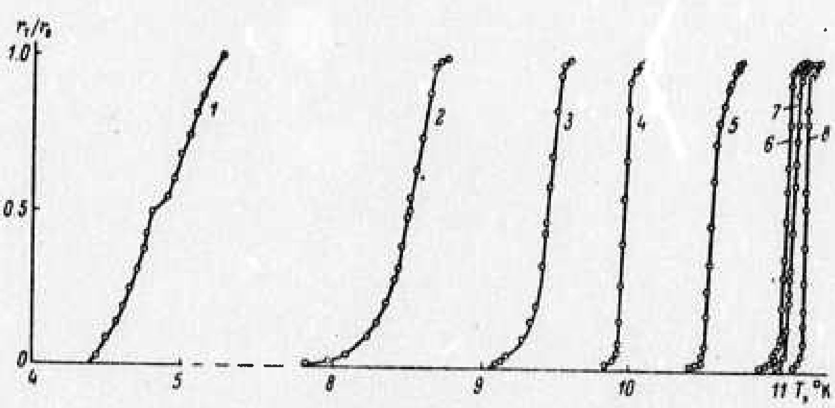

Fig. 1. Curves of transitions of lanthanum into the superconductive state. Pressure, kbar: 1 - 0, 2 - 30, 3 - 40, 4 - 50, 5 - 70, 6 - 100, 7 - 150, 8 - 210.

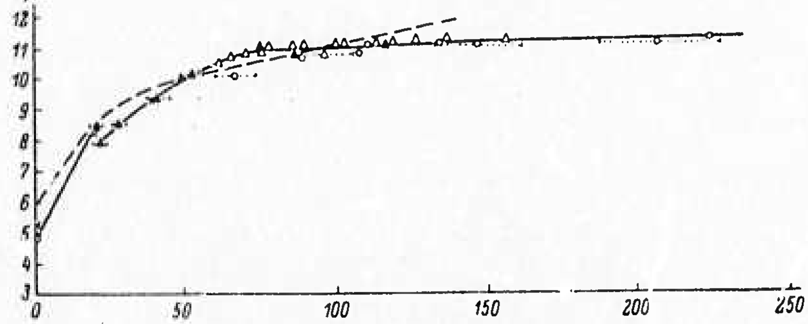

Fig. 2. Relationship of the temperature of the superconductive transition of lanthanum to pressure.

Boundaries of possible errors are indicated by dotted lines.

Mironov, B. P., and N. I. Yarygina. <u>Heat transfer and friction on a permeable surface in a turbulent compressible gas boundary layer.</u> I-FZh, v. 23, no. 5, 1972, 785-791.

Experimental heat transfer and skin-friction data are presented for a supersonic (Mach 2.05-4.0) turbulent boundary layer on a porous surface with air injection. The data are considered to be of great importance to solution of the porous cooling, ablation of heat-insulating coatings during reentry from space, and similar problems. Shock tube experiments were carried out to determine recovery factor r and skin-friction coefficient C_f as functions of injection parameter (permeability) b. The latter was varied over a wide range. It is shown that the experimental heat transfer function $\Psi = (St/St_o)_{Re^{**}}$ and C_f data can be described by approximate formulas derived from rigorous theoretical formulas of Kutateladze and Leont'yev (Turbulentnyy pogranichnyy sloy szhimayemogo gaza. SO ANSSSR. Novosibirsk, 1962). The C_f data were calculated from

the experimental velocity profiles using transformation analogous to that introduced by Cowles. Similarity between the $\Psi(b)$ and C_f (b) functions confirms that there exists a modified Reynolds analogy in a supersonic turbulent boundary layer with mass transfer. The accuracy of the transformation method proposed for C_f determination is however subject to verification.

Khlybov, G. N. and M. Ya. Yakushin. Determining electron density in an air-mixture boundary layer with asbestos plastic destruction products. ZhPMTF, no. 5, 1972, 174-177.

An ablation study of objects in a high-velocity plasma flow is described. Emphasis is given to the effect of the destruction products of the material injected into the boundary layer upon the electron concentration in the high-temperature stream. Plasma velocities of 30 m/sec and temperatures to 8500° K are cited. It was found that in the boundary layer at the surface of an asbestos-plaster model undergoing destruction, the electron density in a stream of high-temperature air at a pressure of 1 physical atmosphere attains 1.2×10^{16} cm^{-3}, which is four times greater than the electron density at the outer boundary of the boundary layer. The change of the electron density in the boundary layer coincides with the change of the parameters which characterize the process of destruction of the material. It is proposed that a special investigation be made of the possibility that the increased value of the electron density, in layers adjacent to the surface of the material, may in principle have a substantial effect on heat exchange.

Dzhafarov, E. O., O. A. Golikova, and L. S. Stil'bans. High-temperature thermal conductivity of group IV transition metal carbides. IAN Az, no. 2, 1972, 123-126.

The thermal conductivity χ of TiC and ZrC was measured at temperatures to 1,700° K as part of a general study of group IV transition metal carbides to explore their possible application as thermocouple leads or switching thermoelements. The simple procedure was used of measuring temperature at two points of the cool end of a specimen, whose opposite end was heated in a vacuum furnace. Solution of the equation of longitudinal temperature distribution gives χ, when the coefficient of emissivity is known. The experimental temperature dependencies of χ_t and the calculated lattice χ_ℓ and electronic χ_e heat conductivity components are presented graphically. Results show that χ_ℓ of both carbides is practically independent of temperature, which is characteristic of a strongly defective crystal structure. Since the authors' χ_ℓ data coincide with that of R. Taylor (J. Amer. Ceram. Soc., v. 44, 1961, 525 and v. 45, 1962, 353), the applicability of the Wiedemann-Franz ratio L is indicated for degenerate free electrons, yielding valuable information on band structure of the group IV transition metal carbides. The high-temperature dependence of electrical and thermal conductivities of the group IV carbides shows that the χ_ℓ and σ values of these carbides remain high even at elevated temperatures. It is concluded that the carbides studied are promising materials for thermocouple switching.

Presnyakov, A. Effect of superlow friction. Sovetskaya Rossiya, October 25, 1972, p. 4.

A group of Moscow scientists at the All-Union Scientific Research Institute of Opticophysical Measurements and the Institute of Chemical Physics, Academy of Sciences, USSR has discovered that when the surface of a polymer solid, e.g. polyethylene, rubbing in a vacuum against a metal, is irradiated by a flux of accelerated helium atoms, there is observed a transition from ordinary friction to superlow friction, in which the value of the friction coefficient is reduced by a factor of about one thousand. During the experiments, the effect was retained over a wide range of speeds and at large specific loads. Analysis suggests that the helium exposure acts to eliminate surface defects in the polymer, approaching a near-ideal surface state.

Udovskiy, A. L., Ye. S. Shmakova, and Yu. I. Mikhin. Physical source of temperature variations in moduli of elasticity of carbon materials. Khimiya tverdogo topliva, no. 6, 1972, 88-94.

A theoretical model is introduced to explain the heat-induced increase observed by Kellett, et al (Carbon, 2, 1964) in elastic coefficients C_{ij} of carbon materials. The authors formulate a quantitative expression of Kellett's ideas based on the temperature dependence of the maxima in elastic moduli of carbographite materials. The thermal expansion of basal planes of a graphite single crystal in a direction normal to the plane (Fig. 1) is expressed by

$$\Delta(T) = d_{002}(T) - 2\langle u_c^2\rangle^{1/2}, \qquad (1)$$

where d_{002} is d-spacing at 0° K and $\langle u_c^2 \rangle^{1/2}$ are the rms thermal atomic shifts. Young's modulus is given by

$$E(T) = \frac{K_1}{\Delta(T)} \frac{\partial^2 U}{\partial r^2}\bigg|_{r=r_0(T)} = \frac{K_2}{\Delta^{n+1}(T)}, \qquad (2)$$

where u is the energy of basal plane interaction, r_o is the spacing between

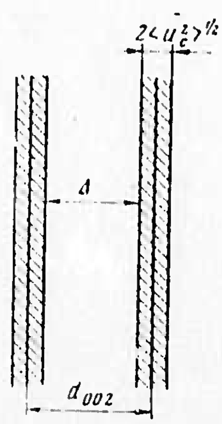

Fig. 1. Positions of basal planes at high temperatures.

the nearest basal planes, and K_1 and K_2 are constants. It is shown that E(T) attains a maximum value at a critical temperature T_{cr} when the mean clearance Δ between the basal planes is minimum. It follows from conditions of the $\Delta(T)$ minimum that

$$T_{cr} = \frac{3h^2}{4\pi^2 m k \theta_c^2 \alpha_c^2} = \frac{12{,}138 \cdot 10^{-16}}{\theta_c^2 \alpha_c^2} \qquad (3)$$

where m is the C atomic mass, k, h are the Boltzmann and Planck constants, θ_c is Debye temperature and α_c is the coefficient of thermal expansion along the C axis. To verify the accuracy of the theoretical model θ_c, α_c, d_{002}, and $\langle u_c^2 \rangle$ were determined from x-ray diffraction patterns of pyrocarbon synthetic, and natural graphite samples at 20-2500° C. The tabulated experimental d_{002} and $\langle u_c^2 \rangle^{1/2}$ values increased with increasing temperature, but Δ calculated from (1) decreased in agreement with the Kellett experimental data.

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vi. Epitaxial Films

Anatychuk, L. I., and O. Ya. Luste. A multi-probe method for measuring resistivity of semiconducting epitaxial films. Otkr izobr, no. 13, 1973, no. 372492.

Kamadjiev, P. R., L. K. Mladjov, and M. M. Gospodinov. Growth, structure and electrical properties of p-Ge--n-CdS_xSe_{1-x} heterojunctions. Thin solid films, v. 12, no. 1, 1972, 135-138. (RZhF, 2/73, no. 2Ye138)

Kudryavtseva, R. V., and S. A. Semiletov. Micromorphology of PbS epitaxial films. Kristall, no. 2, 1973, 427-428.

Lavrent'yeva, L. G., I. S. Zakharov, I. V. Ivonin, N. P. Kolodeshnikova, and T. I. Opryshko. Aspects of growth anisotropy and doping of germanium epitaxial layers in a Ge-I_2 system. Kristall, no. 2, 1973, 369-373.

Loginova, R. G., R. A. Rubtsova, and M. I. Ovsyannikov. Boron migration from an epitaxial layer during vacuum sublimation of silicon. Kristall, no. 2, 1973, 374-376.

vii. Magnetic Bubble Materials

Fabrikov, M. Ye. Device for controlling isolated mobile cylindrical (bubble) magnetic domains. Otkr izobr, no. 13, 1973, no. 372579.

6. Atmospheric Physics

A. Abstracts

Il'in, V. D. Losses of ultrarelativistic electrons in a geomagnetic trap. Kosmicheskiye issledovaniya, no. 4, 1972, 626-627.

A discussion is given on the existence of ultrarelativistic electrons formed by cosmic rays in upper atmospheric strata, with energies of the order of 1 bev, in geomagnetic traps at low altitudes in the near-equator region (altitudes of about 200-600 km), and the probability of their existence in more remote regions of the magnetosphere. An estimate is made of the life span of particles with respect to the loss mechanisms which are essential only for the ultrarelativistic case. These include electron losses due to accumulating changes of the first adiabatic invariant (the magnetic moment of the particles) during multiple reflections, and energy losses as a consequence of synchrotron radiation. A comparison of the indicated mechanisms shows that losses of ultrarelativistic electrons owing to nonadiabatic effects in a static geomagnetic field can be fundamental in a region quite remote from the region of the observation of "excess" radiation.

Zdunkevich, M. D., and V. B. Leonas. Calculating transfer coefficients for planetary atmospheres composed of CO_2-N_2 mixtures. TVT, no. 5, 1972, 1110-1112.

Data on the interaction potentials of the principal paired atomic-molecular combinations are used for calculating the transfer coefficients in a model atmosphere of Mars and Venus (compositions: 50% CO_2-50% N_2 and 95% CO_2-5% N_2, by volume). Calculation of the transfer

coefficients (viscosity, thermal conductivity, and the Prandtl number) is done in the range of temperatures and pressures that encompasses the conditions expected when entering the atmospheres of Mars and Venus. Account is taken of those dissociation products which essentially affect the transfer properties, namely CO_2, N_2,CN, CO, NO, C, N, O, C^+, N^+, O^+NO^+, e^-.

Five tables are presented which show results of calculations of the coefficients of viscosity and total thermal conductivity, with account taken of incident energy, intrinsic energy, and chemical energy, as well as the Prandtl number, for the atmospheres of Mars and Venus within the temperature range from 100 to 12,000°K and at pressures ranging from 10^{-3} to 10^3 atmospheres. A sixth table shows the contribution of various components to the coefficient of thermal conductivity at a pressure of 1 atmosphere for the atmosphere of Mars. A seventh table compares the authors' calculations for the atmosphere of Mars at p = 1 atm. with the results of Freeman and Oliver (AIAA J., no. 9, 1970, 1687). Reasons are given for the noted divergences.

Mitnik, L. M. Measuring moisture content over ocean waters using SHF radiometers on the Cosmos-243 satellite. IN: Trudy Tsentral'noy aerologicheskoy observatorii, no. 103, 1972, 64-72. (RZhIssledovaniye kosmicheskogo prostranstva, 11/72, no. 11.62.163)

Charts are presented of the moisture content W of the atmosphere over the tropical and subtropical latitudes of the Pacific, Atlantic, and Indian oceans, constructed on the basis of measurements of the thermal r-f emission of the Earth from the Cosmos-243 satellite. Moisture content

isolines are drawn at intervals of 0.5 g/cm^2. The particular features involved in the construction of a moisture field are discussed (time variations of the moisture content in various synoptic situations; comparison with moisture content values calculated on the basis of radiosonde data). An analysis of atmospheric moisture charts shows that the distribution of W reflects stable seasonal features of the circulation of the atmosphere. Continents exert a great influence upon the distribution of the moisture content. Thus, in the Southern Hemisphere the boundary between dry air ($W \leq 1.5$ g/cm^2) and moist air ($W \geq 2.5$ g/cm^2) shifts perceptibly northwards when approaching Australia, and particularly when approaching North America. The moisture content of the atmosphere is low over regions of cold currents, e.g. the Labrador, California, Canary, and other cold currents. In foci of elevated atmospheric moisture content, thick cloudiness has been frequently observed, registered both radiometrically and by photographs taken by meteorological satellites and by the Zond-5 space station.

Korchak, A. A., L. A. Lobachevskiy, V. V. Migulin, E. Ts. Rapaport, and I. P. Stakhanov. Radiophysics methods of studying the ionosphere and near-Earth space. Sbornik. X Vsesoyuznaya konferentsiya po rasprostraneniyu radiovoln, Section 1, Moskva, Izd-vo Nauka, 1972, 531-535. (RZhIssledovaniye kosmicheskogo prostranstva, 11/72, no. 11.62.176) (Translation)

Consideration is given to the promising nature of various radiophysics methods of studying the ionosphere and near-Earth space. Further development is required, as well as more extensive use of the following methods: control of fluctuations and deviation of bearing direction; penetration of ionospheric layers by point sources of cosmic r-f radiation; radar observations of inhomogeneities in the polar regions of the ionosphere. The importance is emphasized of investigating various sporadic effects linked to nonsteady processes and disturbances in the ionosphere.

Styro, B. I., and N. K. Shpirkauskayte.
<u>Possible correlation between meteorological processes and fallout concentration with density of long-life alpha-radioactive materials.</u>
Metrologiya i gidrologiya, no. 11, 1972, 94-98.

Consideration is given to some possibilities of using long-life radioisotopes for studying the mechanism of the passage of air masses across the tropopause, as well as using these data for the prediction of individual cases of increase of the concentration of α-emitting radioactive substances at the Earth's surface. A three-dimensional analysis of the meteorological processes was conducted in accordance with the principle for the classification of macroprocesses proposed by A. L. Kats. This consists in the geographic localization of altitude crests and troughs over the Atlantic-Eurasian sector of the Northern Hemisphere (from 30° W to 110° E in the zone of 35-70° N), according to the indices of zonal and meridional circulation. A study was made of the relation between the four basic forms of circulation (westerly, central, easterly, and mixed) and the penetration of stratospheric air into the troposphere, and of the radioactive substances, accompanied by α-radiation, that penetrate into the troposphere together with the stratospheric air.

The analysis of atmospheric circulation was conducted for the period from October, 1966 through December, 1969. An analysis of the monthly atmospheric fallout of α-radioactive substances was made in Vilnius during the same period of time. An analysis of the relation of the fallout of α-radioactive substances to the total amount of the monthly precipitation did not however yield positive results.

A correlation was discovered between the value of α-fallout and the mixed form of atmospheric circulation, although the fallout of α -radioisotopes did not always accompany the mixed form of circulation. It was ascertained that favorable conditions for the passage of stratospheric air across the tropopause over Latvia are created at large gradients of the pressure field and in the presence of large temperature gradients, these conditions being created when the appearance of the mixed form of circulation is preceded by the form of meridional circulation with a western position of the altitude crest. It was found that the appearance of the mixed form of circulation is preceded in 70% of the instances not by the "western" form, but by the form of circulation with a central position of the altitude crest, or else there predominates over the Baltic region a circulation of any form, but with a zonal component. In these cases, a sharp decrease in the altitude of the tropopause over the Baltic region is not observed.

Komarnitskaya, N. I. Capture by the Earth of dust particles moving in a near-ecliptic plane. Astronomicheskiy vestnik, no. 1, 1972, 35-43.

The density of dust particle flow in the neighborhood of Earth and the effective radius of capture have been calculated by various approximate methods. The author attempts to calculate these parameters more exactly from the equations of a restricted three-body problem, taking into account the pressure of light. In the properly selected system of coordinates, the system of equations describing the motion of dust particle was derived and integrated on a Minsk-2 computer by the Runge-Kutta method with an error of 10^{-4}. Factors governing the proper selection of a coordinate system and of the numerical integration are analysed.

Geocentric trajectories of particles moving in the plane of the ecliptic with and without accounting for light pressure are presented by graphs. "Corridors" in the ecliptic plane from which the dust particles can be captured by the Earth, are identified and the corresponding effective capture radii are calculated. The variation of dust particle density in the vicinity of Earth in certain directions is analysed, and the dependence of the density logarithm on the distance from Earth is graphically represented. The influence of the moon on Earth capture of dust particles is also considered. Analysis of latter problem shows that the moon can have a definite effect on dust capture only when the capture "corridor" is sufficiently close to the moon.

Ovchinnikov, G. I., and V. I. Tatarskiy.
Relationship of theory of coherence and the radiation transfer equation. IVUZ Radiofiz, no. 9, 1972, 1419-1421.

A radiation transfer equation can be derived from equations for the coherence function; however, some difficuties arise in this connection which are analysed by the authors. In the coherence theory the boundary-value problem is formulated for the coherence function $\Gamma(n, R)$ which for a homogeneous medium satisfies two Helmholtz equations, while the radiation transfer equation is defined for the coherence function angular spectrum $I(n, R)$ at the given initial value $I_o(n, R_\perp)$ on the domain boundary.

The relations between $\Gamma(n, R)$ and $I(n, R)$ are written in the form of two equations. It is shown how the radiation transfer equation is derived from the equations for the coherence function, which at a given I_o $(n, R_\perp)$ has a unique solution $I(n,R)$. From equations for $\Gamma(n, R)$ and $I(n, R)$ it is however impossible to express the initial distribution $I_o(n, R_\perp)$ in terms

of initial distribution $\Gamma_0(\rho, R_\perp)$. Hence an arbitrary selection of $I_0(n, R_\perp)$ can lead to conclusions which are inconsistent with rigorous diffraction theory. The authors establish the conditions under which the proper selection of the initial angular spectrum $I_0(n, R_\perp)$ can be made, and the coherence function, on the basis of solution of the radiation transfer equation can be established.

Vollerner, N. F., and B. Ye. Lukoyanov. Study of blizzard radio interference in the Arctic. IVUZ Radioelektr., no. 2, 1973, 89-97.

Methods and equipment used in experimental studies of radio interferences in Arctic under blizzard conditions are described. For correct statistical analysis of this type of random process, the interference measuring system of Fig. 1 was used. The article examines the statistical characteristics

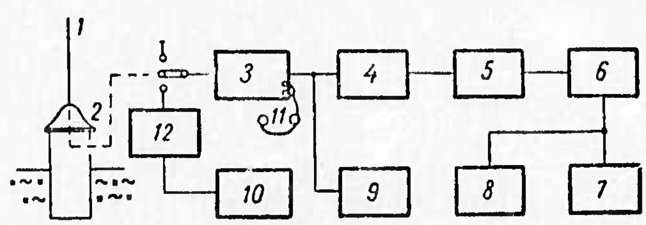

Fig. 1. Block diagram of blizzard radio interference measuring equipment.

1-antenna; 2- matching network; 3- receiver unit; 4- converter; 5- bandpass filter; 6- amplifier; 7- tape recorder; 8- oscillograph; 9- square law voltmeter; 10- GSS; 11- headphone; 12- dummy antenna.

of blizzard interference and estimates the effects of meteorological conditions (wind velocity, temperature and air humidity) on interference levels. On the basis of experimental data the one-dimensional distribution functions of blizzard interference field intensity and its statistical characteristics, such as mean value, variance, autocorrelation function, regression lines and others are estimated. Statistical processing of experimental results led to the following conclusions:

1. The effect of blizzard interference on signal reception becomes perceptible at a snow-bearing wind velocity ≥ 7 m/sec.

2. The main factor determining the level of blizzard interference is the velocity of the wind plus snow; this shows a linear correlation, whereas the effects of temperature and air relative humidity are negligible.

3. The data obtained on blizzard interference levels are in the range of 0.1 - 10 MHz at various wind velocities.

4. The probability distribution of the blizzard interference intensity field corresponds to a probability distribution of the wind plus snow velocities.

5. The amplitude distribution of the blizzard interference envelope effectively follows a normal distribution, with a degree of fit equal to $p(\lambda) = 0.45 - 0.89$.

6. The correlation time of blizzard interference in the ~6KHz band is in the range $t_{corr.} = (1 - 2.5)10^{-3}$ sec.

Goryachev, B. V., B. N. Denchik and B. A. Savel'yev. <u>Statistical characteristics of radiation propagation in scattering media with strong anisotropy of the scattering index.</u> IVUZ Fiz. no. 2, 1973, 116-118.

An experimental study is described of characteristics of transmitted radiation in model media, composed of particles whose optical characteristics are close to hydrometeorological (rain, snowfall, etc.). The medium under study was composed of polystyrene beads suspended in distilled water with relative particle refraction index m = 1.21. The rms radius of particles r = 0.285 mm, and scattering density was approximately 193 cm^{-3}.

The intensities of incident attenuated radiation, at an angular receiver aperture $\theta = 6'$, and of the scattered radiation in the angular directions $\theta_2 = 10'-15'$; $\theta_3 = 10'-20'$ and $\theta_4 = 10'-30'$, were recorded. The results are given graphically showing the dependence of directly attenuated and scattered radiations on the optical thickness of medium. The curves are analyzed and compared with corresponding curves obtained in previous studies. It is pointed out that a change in optical thickness of media results in a change in distribution laws of intensity fluctuation probability.

Luyev, V. E., G. M. Krekov and A. I. Popkov. Statistical estimation of light pulse distortion in probing of plane-stratified clouds. IVUZ Fiz, no. 2, 1973, 50-53.

A brief review is given on lidar probing of cloud layers. The general case is for a laser beam, with divergence angle φ_{rad} from a collimation system with the aperture R_{rad}, directed vertically upwards. The receiving system consists of a parabolic mirror with radius R_r and viewing angle φ_r located at a baseline distance Δ from the transmitter. A pulsed laser made with a Gaussian envelope shape is assumed.

The scattering medium is a plane stratified layer of clouds, which is perpendicular to laser beam and appears at some distance D from the transmitter. The optical model of the cloud mass is defined by given volumetric scattering and attenuation coefficients, the albedo of cloud particles, and tables of scattering functions. The above parameters were calculated at given wavelengths using rigorous expressions of e-m wave theory. It is further assumed that the spectrum of cloud drop dimensions obeys a generalized gamma distribution. A numerical Monte Carlo method, using the exact form of the scattering index, is used to solve the radiation transfer equation. Results of statistical simulation obtained by a BESM-6 computer are presented in three graphs. Continuous curves represent the deformation of the reflected light pulse at various numerical parameters of the experiment. Fig. 1 for example illustrates the dependence of a ruby laser pulse shape reflected from a finite optical thickness cloud on the volumetric attenuation coefficient.

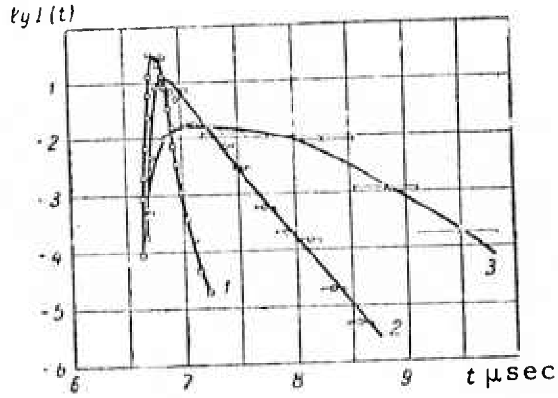

Fig. 1. Reflected pulse shape vs. volumetric attenuation at a fixed optical thickness $\tau = 5.0$ and laser $\lambda = 0.69\ \mu$. Cloud depth = 10 m (1); 50 m (2); and 300 m (3).

Gorelik, A. G., L. V. Knyazev, and L. N. Uglova. Radar returns from a "clear sky" in the decimeter range. FAiO, no. 2, 1973, 190-194. Gorelik, A. G., L. V. Knyazev, L. G. Kotov, Ye. F. Orlov, and L. N. Uglova. Improved methods for statistical analysis of radar echoes, with application to studies of turbulence and vertical circulation. IN: Trudy Tsentral'noy aerologicheskoy observatorii, no. 103, 1972, 100-112.

The authors briefly cite advantages of using pulsed Doppler radar probing in the decimeter band for determining the kinetics of small-scale reflecting atmospheric layers, both for cloudy or clear skies. The system, shown in Fig. 1, uses optical analysis of the return signals to obtain altitude-frequency and altitude-time characteristics of the reflecting layers. The Doppler shift spectrum obtained from the phase detector had a resolution of 0.3 m/sec for vertical atmospheric shift.

Tests made during the summer months of 1970 and 1971 in central European USSR showed the following types of return from skies ranging from totally clear to cloudy with precipitation:

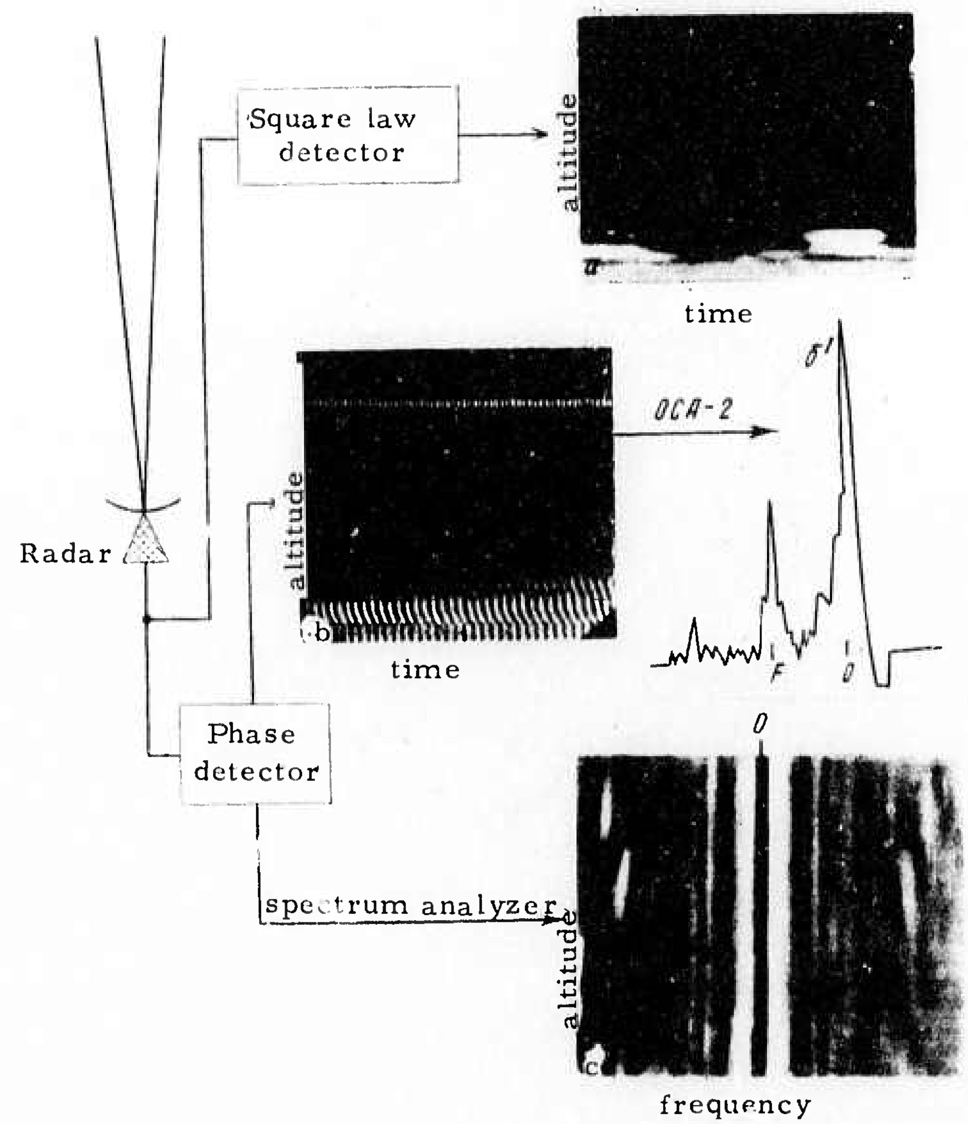

Fig. 1. Vertical probe using pulsed decimeter radar. a- intensity modulated altitude-time trace, b- altitude-time trace from phase detector (lower traces are ground clutter); c- spectrum analyzer output.

1. Return from upper boundaries of cumulus. This occurred relatively infrequently and was typified by a downward velocity gradient up to 0.6 m/sec. A sharp discontinuity in refractive index appears the most likely cause of this type of echo, which is consistent with refractometry data on cumulus cloud.

2. Reflection from an inclined layer. Returns of this type were typically recorded for 2-3 minutes, sometimes to 5 min., at altitudes of 7 to 10 km. Lateral movement of the inclined layer gave an apparent vertical gradient of some 6 m/sec; the Doppler spectral width was not over 1 m/sec. Inversion and isothermic layers were also detected in this type.

3. Concave layer reflection typically as in Fig. 2 with maximum intensity at the curve bottom around 5 km height, and extending up to 10 km on either side. Sequences of this type occasionally were observed at intervals of about 1 minute between curves. Spectral analysis showed vertical rates ±3 m/sec near the bottom portion of such surfaces. The concave type generally appeared above cloud layers, extending up to the tropopause. No satisfactory explanation seems available for this response type.

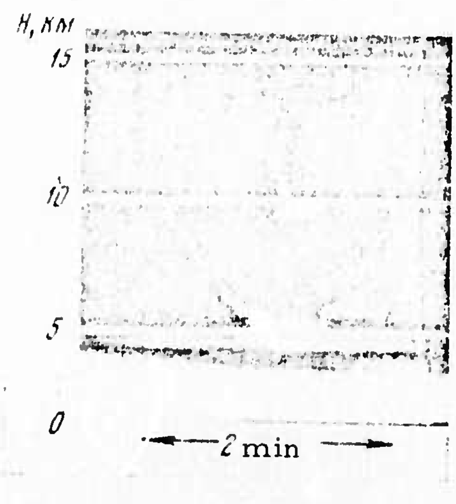

Fig. 2. Return from concave reflecting layer.

4. Discrete nocturnal reflections. These were returns from local regions having linear dimensions ~400 m and heights up to 800 m. Returns of this type appeared shortly after sunset and rose to a peak around 2200 hours, when as many as 100 per hour have been registered, lasting from 20 seconds to 2 minutes. Vertical velocity profiles of this type show a predominantly upward motion at lower levels around 1000 km, and a downward tendency for regions at 2000 km and above. The authors' radar return data enabled them to deduce air parameters at the boundaries of these volumes, e.g. temperature, elasticity and refractive index gradients.

In the second cited work the authors expand on the same subject, with a more detailed description of the receiver and optical analysis techniques. Additional data are also given on atmospheric echo data under various conditions; evidently these tests were mostly done at a 30 cm. wavelength.

The authors conclude that pulse Doppler probing techniques in the decimeter range should be explored further for studying atmospheric microstructures.

Raspopov, O., Kochenevsky, V. et al.
Characteristics of Pi2 type pulsation spectra along a meridian profile. C. r. Acad. sci., v. 275, no. 13, 1972, B465-B468. (RZh Geofiz, 4/73, no. 4A342)
(Translation)

During March-April 1968, an experiment was conducted on registering Pi2 pulsations at nine stations, spaced from 64° to 46° north latitude along approximately the same meridian. At high and medium lati-

tudes several maxima were noticed in Pi2 spectra, depending on magnetic activity. Frequencies of the first two main maxima were nearly constant at all stations. The spectral density at high frequencies increases at observation point latitudes. The amplitude of Pi2 pulsations, in addition to peaking in the auroral zones, has a secondary peak at 50^{o}-60^{o} north latitude, which may be connected with the location of the plasmapause.

Il'in, N. S., and I. A. Greym. Study of vertical differential refraction in the surface boundary layer. IN: Nauch. tr. Omsk. s-kh. in-ta., no. 80, 1972, 80-86. (RZh Geod, 2/73, no. 2.52.100) (Translation)

A study is described on the relation of refraction with distance, measured by DD-3 (range finder coefficient k = 100) and DD-5 (k = 200) DME's. Studies were made in the Estonian SSR, eastern Kazakhstan and in the Omsk region; more than 25,000 separate measurements were taken. Curves were drawn which characterize refraction effect as a function of measured distance, weather, and time of day, with the following conclusions. Refraction starts to be a noticeable factor at ranges over 100 meters. For distances of the order of 250 m errors reach 1:500. The refraction effect appears to be stronger when using the range finder with k = 200. The most adverse observation period is from 1100 to 1600 hours. It is generally recommended that corrections be made to range measurements over 100 m in sunny weather during the summer. Correction figures due to refraction are cited for ranges measured by DD-3 and DD-5 range finders during the June - September period over grassy terrain in central Russia.

Gul'yel'mi, A. V., V. A. Troitskaya, B. V. Dovbnya, and A. S. Potapov. Diagnostics of cold plasma and energetic particles by means of dispersion analysis of pearls. IN: Sbornik. Issled po geomagnetizmu, aeron. i fiz. solntsa. Irkutsk, no. 24, 1972, 3-12. (RZh Geofiz, 4/73, no. 4A306) (Translation)

Processing and analysis are described of a large number (about 100) of dynamic pearl spectra. A set of diagnostic graphs are constructed which facilitate extraction of information on the magnetosphere by means of dispersion analysis. Cold plasma concentration at great altitudes, and the energy and positions of resonance protons are determined which are responsible for pearl excitation. Results of the dispersion analysis are compared with previously obtained diagnostic results according to abrupt jumps in pearl carrier frequency during sudden deformations of the magnetosphere.

Gul'yel'mi, A. V. A theory of discrete forms of hydromagnetic emission. IN: ibid., 13-22. (RZh Geofiz, 4/73, no. 4A307) (Translation)

Pearl-type discrete signals (geomagnetic pulsations in the vicinity of 1 Hz) appear in the outer radiation belts during continuous excitation. The author suggests an explanation for this phenomenon. Classifications are given of low-frequency wave generation regimes in the outer radiation belts. Experimental data on pearls are discussed from the viewpoint of the proposed theory.

Vinogradov, P. A., and V. N. Vinogradova. On the relation between parameters T, τ and t of Pcl pulsations. IN: ibid., 71-78. (RZh Geofiz, 4/73, no. 4A308) (Translation)

Relationships are developed between carrier oscillation period T, structural element repetition period τ and recurrent series repetition period t. Sequential evolution of pearls and the change of τ are studied. Typical values are cited of parameters characterizing Pcl series. Values are determined at $\Lambda\tau = \tau - \tau/t$ for isolated series. The overall drop in $\Lambda\tau$ from the initial to the middle of a series amounts to 0.12.

Vinogradova, V. N., and P. A. Vinogradov. Variations of Pcl intensity. IN: ibid., 79-83. (RZh Geofiz, 4/73, no. 4A309)(Translation)

Pcl events were simultaneously recorded at points differing in geological profile characteristics; and the strong correlation of Pcl amplitude in telluric currents with local conductivity anomalies is verified. Diurnal variations of average amplitude Pcls, Pclsc and Pcl with T > 2 seconds are identical with diurnal behavior of frequency behavior. The intensity of Pcls peaks in the night and early morning hours, and decreases by about 2 times in day hours. A midday peak is noted for Pcl with T > 2 sec. and Pclsc at mid-latitudes. The average amplitude of Pcl drops by a factor of two from winter months to summer and from minimum to maximum solar activity; this corresponds to the change in ionospheric absorption of oscillations in the Pcl frequency range.

Vinogradova, V. N. Time duration of Pcl series. IN: ibid., 84-88. (RZh Geofiz, 4/73, no. 4A310). (Translation)

Variations in time duration are studied of Pcl series and the time period is cited of discrete Pcls and Pclsc occurrences during 1957-69. The duration is maximum for Pcl occurring at 0400-0800 hrs, and minimum for series which begin at 1100-1500 hrs local time. Recurrence frequency of extended series show sharp seasonal variations with an extreme minimum in summer and maximum in winter. The recurrence period of prolonged series is maximum in a decreasing phase and minimum in the maximum phase.

Vinogradova, V. N., and P. A. Vinogradov. Geographical distribution of Pcl. IN: ibid., 86-95. (RZh Geofiz, 4/73, no. 4A311) (Translation)

Spatial correlations and westerly drift effect of amplitude peaks in Pcl are studied. The spatial correlation of Pcl increases from day to night hours and from summer to winter, and decreases with the increase of carrier oscillation periods. During rise and fall of solar activity and at minimum phase, regional and global Pcls predominate; in the maximum activity phase, local Pcls predominate.

Vinogradov, P. A., and V. N. Vinogradova. Correlation between Pcl parameters at stations on a meridional profile. IN: ibid., 96-102. (RZh Geofiz, 4/73, no. 4A312) (Translation)

A study is made of correlation between Pcl parameters at stations on a meridional profile. The simultaneous appearance of Pcl is characteristic for night and morning hours in winter months. Most of the local Pcl events have low intensity, and are observed at day hours during summer. When propagating along a meridian (at distances ~1000 km), diurnal attenuation is two times greater than nocturnal.

Vinogradova, V. N., and P. A. Vinogradov. The regional anomaly at Pcl occurrence frequency. IN: ibid., 103-105. (RZh Geofiz, 4/73, no. 4A313) (Translation)

A diversity is found in Pcl recurrence periods at different stations by comparing A-t recordings. Corrections taking into account relationships of amplitude with geoelectrical characteristics and variations in recording apparatus parameters are not sufficient to explain this diversity. It is suggested that the increase of Pcl recurrence periods in the Irkutsk region may be due to the effect of the Eastern Siberian magnetic anomaly.

Vinogradov, P. A., and V. N. Vinogradova. Diurnal distribution of Pcl. IN: ibid., 106-112. (RZh Geofiz, 4/73, no. 4A314). (Translation)

Based on systematic observations from 1958 through 1970, a study has been made on the diurnal distribution in recurrence frequency of Pcl of various types. Seasonal, cyclic and latitudinal changes are analysed of diurnal variations in Pcl recurrence probability.

Vinogradova, V. N., and P. A. Vinogradov. The annual variation of Pcl occurrence frequency. IN: ibid., 113-118. (RZh Geofiz, 4/73, no. 4A315) (Translation)

The annual variation in occurrence frequency of various Pcl types are examined on the basis of thirteen systematic summer observations.

Vinogradova, V. N., and P. A. Vinogradov. Variations of Pcl occurrence frequency over a solar activity cycle. IN: Ibid., 119-127. (RZh Geofiz, 4/73, no. 4A316)(Translation)

Cyclic variations are discussed in the occurrence frequency of Pcl of different types and intensities, according to observations in Irkutsk from 1957-70.

Vinogradov, P. A., and V. N. Vinogradova.
Geomagnetic storms and Pcl occurrence.
frequency. IN: ibid., 128-137. (RZh Geofiz,
4/73, no. 4A317)(Translation)

Pcl occurrence of different types and intensities was investigated over periods from 5 days before a storm to 10 days after the storm, as observed from October 1957 through December 1970.

Vinogradov, P. A., and V. N. Vinogradova.
The 27-day recurrence tendency of Pcl. IN:
ibid., 142-148. (RZh Geofiz, 4/73, no. 4A318)
(Translation)

The 27-day recurrence tendency of Pcl is discussed. A Pcl recurrence time chart and yearly average curves of 27-day Pcl recurrence from 1958 through 1970 are presented.

Vinogradov, P. A., and V. N. Vinogradova.
Proton flares and Pcl activity. IN: ibid.,
149-153. (RZh Geofiz, 4/73, no. 4A319)
(Translation)

Pcl frequency occurrence of various intensities is investigated from 5 days before and up to 10 days after proton flares.

Vinogradov, P. A., and V. N. Vinogradova. Parameters of the ionosphere and Pcl activity. IN: ibid., 154-163. (RZh Geofiz, 4/73, no. 4A320) (Translation)

The relationship of Pcl frequency occurrence is investigated as a function of ionospheric E- and F2-layer parameters. A correlation is found between periods of Pcl carrier oscillations and f_oF2.

Vinogradov, P. A., and V. N. Vinogradova. Pulsations with a decreasing period. IN: ibid., 164-171. (RZh Geofiz, 4/73, no. 4A321) (Translation)

A discussion is given of some standard geophysical investigations: diurnal, seasonal and eleven summertime variations are analysed of the probability of oscillation intervals with a decreasing period. The relationship of the properties of oscillations with decreasing periods is examined as a function of solar and geomagnetic activities.

Vinogradov, P. A., V. A. Parkhomov, T. N. Polyushkina, R. A. Rakhmatulin, and N. P. Soboleva. Parametric relation of steady oscillations with magnetic and solar activity levels. IN: ibid., 217-222. (RZh Geofiz, 4/73, no. 4A327) (Translation)

The relationship is investigated of stable regular Pc3 oscillations to magnetic and solar activity levels. Extensive analysis of

statistical data showed that 1) the period of regular Pc3 oscillations decreases from minimum to maximum solar activity; 2) an inverse relation is observed of Pc3 period relative to magnetic activity; 3) the observed period range narrows down with rise in magnetic activity.

Vinogradov, P. A., and V. A. Parkhomov. Dependence of Pc2-4 pulsation period on interplanetary magnetic field intensity. IN: ibid., 223-226. (RZh Geofiz, 4/73, no. 4A328) (Translation)

The relation is investigated of Pc 2-4 periods to the value of total intensity vector of the interplanetary magnetic field (IMF). At K_p = 3-5, an inverse relation is observed of period vs. IMF intensity, while in the K_p = 0-2 range, the relation is ambiguous. The possibility is considered of Pc 2-4 occurrence as a result of the presence of Alfven waves in solar wind.

Vinogradov, P. A., and V. A. Parkhomov. Relation between Pc3 pulsation activity and interplanetary magnetic field orientation. IN: ibid., 227-231. (RZh Geofiz, 4/73, no. 4A329) (Translation)

The effect is considered of interplanetary magnetic field (IMF) direction on Pc3 pulsation activity. Orientation of the field is not always the controlling factor in Pc3 excitation. It is necessary to take into account other parameters (solar wind velocity, modulus of IMF intensity, earth's location relative to the sectoral structure boundary) in using observed relationships for diagnosis.

Vinogradov, P. A., and V. A. Parkhomov.
Change of regular Pc 2-4 pulsation period during the interaction of a solar flare shock wave with the magnetosphere. IN: ibid., 242-248 (RZh Geofiz, 4/73, no. 4A330) (Translation)

Variation in Pc2-4 period is investigated at the moment of the interaction of shock waves from flares with the magnetosphere. The exponent ν in the relationship $T = \text{const}\ R^{\nu}$ is determined according to the change of magnetospheric boundary locations and the corresponding change in periods. In certain cases the Pc 2-4 period does not change at the moment of SSC, but up to 1 hour later.

Vinogradov, P. A., and V. A. Parkhomov.
The large-scale interplanetary magnetic field structure and activity of Pc3 geomagnetic pulsations. IN: ibid., 249-257. (RZh Geofiz, 4/73, no. 4A331) (Translation)

The behavior of Pc3 activity is investigated with reference to the sectoral boundary of the interplanetary magnetic field (IMF) structure. Minimum activity is observed at the sectoral boundary, maximum some minimum 2-3 days after Earth's crossing of the boundary. The observed behavior is stable during a solar activity cycle. A correlation of pulsation activity with large-scale variations in solar wind velocity is verified. It is assumed that the interplanetary excitations are connected with the sectoral structure of the IMF.

Vinogradova, V. N. Catalogue of pulsation intervals of decreasing period, according to observations in Irkutsk during 1958-71. IN: ibid., 296-306. (RZh Geofiz, 4/73, no. 4A335) (Translation)

A catalogue is given of oscillations with decreasing period according to observations in Irkutsk during 1958-71.

Sobolev, A. V., and A. A. Danilov. Geometrical effect of solar corpuscular flux on geomagnetic pulsations. IN: ibid., 213-216. (RZh Geofiz, 4/73, no. 4A326) (Translation)

The geometrical effect of solar corpuscular flux is investigated on type Pc3 geomagnetic pulsations. A relationship is developed of pulsations as a function of Earth's location in the flux, i.e. Pc3 amplitude is larger if the flux envelops the axial part of earth, and smaller if the periphery is covered. The maximum amplitude is observed during Earth's exit from the flux. The geometrical effect is present only in fluxes connected with active regions of the northern Solar hemisphere, being absent in fluxes from southern hemisphere. Regarding this effect, a close relationship exists between changes of pulsation amplitudes and galactic cosmic ray variations, which indicate the dependence of Pc3 pulsations on the interplanetary magnetic field.

Fedyakina, N. I. Daily variation of ultra-long wave amplitudes in Arctic communication lines. IN: Tr. Arkt. i antarkt. NII., no. 310, 1972, 156-163. (RZhF, 2/73, no. 2Zh128) (Translation)

Regular fluctuations are investigated of daily signal variations at 16.0 and 18.6 kHz due to the change in NP exposure of communication lines in drift station North Pole-13. The mean monthly diurnal variation of field intensity E(t) for every month from August 1965 through January 1966 is represented with respect to the minimum daily level, and corresponds to smooth and low-excitation propagation conditions. Maxima of E(t) are connected with the passing of light and shadow lines near the transmitter. Based on experimental results, it is concluded that the daily E(t) variation is determined by conditions of communication line exposure, and the regular solar ionization wave is the ionization source of the lower ionosphere. Effects of sporadic ionization of the E-layer and corpuscular radiation in polar cap regions on diurnal E(t) variation were insignificant during the period studied. Experimental values are compared with calculations. Calculations are done by means of normal wave theory for paths consisting of a nocturnal part, where heights up to 50 km are not exposed, and a diurnal part, where they are. Propagation parameters derived for the mid-latitudes are used in these calculations. Experimental and theoretical results are in good agreement. Discrepancies are noted in sunrise and sunset periods in the mid-latitude segment of the communication line, and in the exposure period of its high-latitude segment.

Van'yan, L. L., L. A. Abramov, M. B. Gokhberg, and V. L. Yudovich. Hydromagnetic waves directed by the geomagnetic field. IN: Sbornik. Mezhplanet. sreda i fiz. magnitosfery. Moskva, nauka, 1972, 26-32. (RZh Mekh, 3/73, no. 3B10) (Translation)

Characteristics of magnetohydrodynamic waves are investigated propagating in the magnetosphere from a source of finite dimensions. It is shown that they are closely connected with electric currents along geomagnetic lines of force. The concepts developed may give a theoretical basis for interpreting pulsations and polar bights.

Ralchovski, T. M. Effect of geomagnetic activity on occurrence of whistler atmospherics. DBAN, no. 12, 1972, 1629-1632.

Tests are described which sought a correlation between whistler occurrence and changes in geomagnetic activity. Data on the latter were from the ESSA Labs at Boulder; this was compared to whistlers registered over two-minute intervals at Sofia and Panska Ves, Czechoslovakia from September 1970 to August 1971. Whistler rate as such was not a criterion, merely the presence or absence of a whistler in a given two minute interval. Occurrence was denoted by W_k, the percentage of periods for a given K_p value in which whistlers appeared. The summary results for the two stations are seen in Fig. 1, showing a definite K_p correlation. Whistlers were

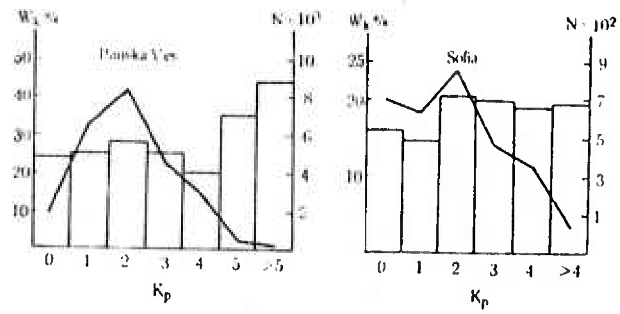

Fig. 1. Whistler probability W_k vs. activity K_p

also minimal under steady K_p conditions and in fact were mostly observed at night when magnetic conditions change abruptly. A further study of the observed correlation is scheduled.

Sarychev, V. T. Excitation of ion concentration by a moving body in the ionosphere. GiA, no. 1, 1973, 171-173.

Excitation of charged particle concentration in the ionosphere by moving satellites was discussed by Al'pert et al (Iskusstvennyye sputniki v razrezhennoy plazme. Izd-vo AN SSSR, 1964), but effects of reflection from the satellite body were not taken into account. In the present work, the author derives a general expression for ion concentration in the neighborhood of an arbitrary body, taking into account shading and reflection in the presence of a uniform magnetic field.

Calculations are illustrated for ion concentration increase due to reflections, and results are plotted graphically. It is shown that in the case of a body velocity V parallel to the magnetic field, the thermal ion scattering smooths out into a periodic structure, while at an angled V

the thermal effects are so great that the magnetic field has no significant effect on the concentration of reflected ions.

Ol', A. I. <u>Electric current as a heating source in the E-layer.</u> IN: Tr. Arkt. i antarkt. nauch-issled. in-ta., no. 310, 1972, 60-65.

The author considers joule heating of the ionosphere over polar auroral zones, where strong jet currents flow during magnetic excitations. The analysis briefly reviews previous works by different authors and illustrates discrepancies in the value of q (erg $cm^{-3} sec^{-1}$) i.e. heat liberation rate per unit volume. It is pointed out that to compute q from values of current density, it is necessary to take into account the effects described by Pikel'ner (Osnovy kosmicheskoy elektrodinamiki. M., nauka, 1966). That is, during movement of a plasma in a magnetic field, due to the electric field not only the movement of ions with respect to electrons (electric current) takes place, but also the plasma moves as a whole (i.e. ions and electrons) with respect to neutral gas particles. Energy dissipation from electric currents correspond to joule heating, while the energy dissipation of the plasma movement as a whole is determined by electrodynamic forces of the moving plasma. An approximate expression is derived for q in auroral electric flux:

$$q = 2.5 \times 10^{14} j_{\perp} ,$$

where $j_{\perp}$ = current density normal to the geomagnetic field direction. The author concludes that joule heating during moderate and strong magnetic excitations may reach $q = 2.5 \times 10^{-5} - 2.5 \times 10^{-4}$ erg · $cm^{-3} sec^{-1}$, which corresponds to a heat flow of 25-250 erg · $cm^{-2} sec^{-1}$ at a layer thickness

of 10 km. It is also pointed out that accurate calculations of temperature increase in the E-layer during magnetic excitations and polar aurorae are difficult owing to uncertainty of the heat dissipation mechanism. The spectroscopic methods of temperature observations used to date are considered inadequate for solving heating problems in the E-layer.

Savun, O. I., I. N. Senchuro, P. I. Shavrin, and V. I. Shumshurov. Radiation dose distribution in Earth's radiation belts during years of maximum solar activity. Kosmicheskiye issledovaniya, no. 1, 1973, 119-123.

Results are described of the ionization chamber measurements of absorbed radiation doses along the flight path of the Molniya-1 satellite which was launched on December 25, 1970 into an orbit with apogee ~3900 km, perigee ~500 km and inclination of 65°. The orbit of Molniya-1 enabled it to obtain information on radiation dose distribution in practically all regions of the inner and outer radiation belts. The ionization chamber was located in a detector package, which was fixed outside the satellite. Shielding threshold for particles penetrating into the chamber was ~0.7 g/cm^2 (plexiglas and aluminum).

The distribution of absorbed doses was typical for geomagnetically quiet periods during times close to maximum solar activity (January 1971). Maximum dose power at the center of the inner belt was ~520 rad/day for a threshold of ~0.7 g/cm^2 over 4π sterad., and in the outer belt - 130 rad/day. Compared to 1964, the maximum dose power was found to have decreased by ~20 times, which is associated with disintegration of the radioactivity from the Starfish high altitude thermonuclear explosion.

B. Recent Selections

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Zavorotnyy, V. U., and V. I. Tatarskiy. Quantum fluctuations of photon flux from propagation in free space and in a diffraction pattern. ZhETF, v. 64, no. 2, 1973, 453-462.

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7. Miscellaneous Interest

A. Abstracts

Vinogradov, A. P., V. I. Nefedov, V. S. Urusov, and N. M. Zhavoronkov. X-ray analysis of metallic iron in lunar regolith. DAN SSSR, v. 207, no. 2, 1972, 433-436.

This is a report on the results of x-ray analysis of metallic iron in the lunar regolith, brought back from the Ocean of Storms and the Apollo C crater by the Apollo-12 spacecraft and the Luna-20 automatic station, respectively. Comparison of the Fe2p lines in regolith from the Apollo C crater and the Sea of Fertility shows that the fraction of unoxidized iron in the sample from the Apollo C crater is twice that in the sample from the Sea of Fertility, as shown in Fig. 1. However, if it is taken into account that the total fraction of oxidized iron in the regolith from the Apollo C crater is two to three times less than that from other regions of the Moon, the relative surface fraction of unoxidized iron in the total composition of regolith is approximately identical for the mountainous and sea regions.

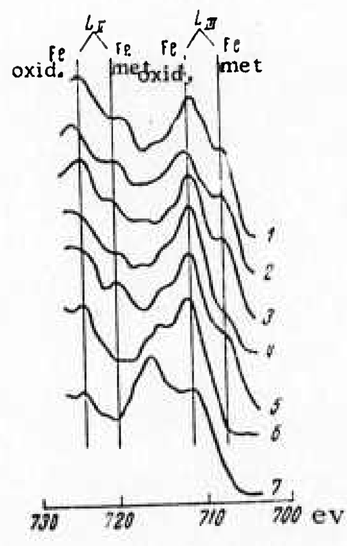

Fig. 1. Fe2p lines of lunar regolith:
1-3 - Luna-20; 4 - Apollo-12; 5 - Luna-16, unpulverized specimen; 6 - Luna-16, carefully pulverized specimen, typical curve; 7 - Luna-16, unusual curve.

The authors also conducted a number of experiments to determine the reasons leading to formation of metallic iron oxidized comparatively weakly by atmospheric oxygen. The results are shown in Fig. 2.

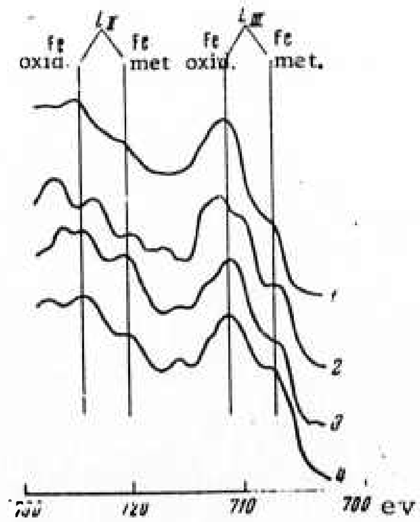

Fig. 2. Fe2p lines: 1 - Sikhote-Alin'skiy meteorite, deposited on glass in a vacuum of 10^{-8} torr; 2 - iron (C:0.1%) after cleaning by Ar^+ ions (November 1970; 6 keV, 0.2 a/cm^2; 3 - especially pure iron (suface unchanged for ~ 1.5 years); 4 - vacuum deposited basalt.

These studies indicate that non-meteoritic lunar iron is concentrated on the surface of regolith particles, and that the surface concentration shows little correlation with internal concentrations of iron oxides.

Dmitriyev, M. T., V. M. Deryugin, and G. A. Kalinkevich. Optical emission from ball lightning. ZhTF, no. 10, 1972, 2187-2189.

Optical emission characteristics of a ball lightning occurrence in the 360-700 mμ spectral range were determined. The authors' hypothesis of the emission origin in the central sector contradicts the assumption of a surface-originated emission which follows from the findings of Barry (J. Atm. Terr. Phys., v. 29, 1968, 1095). Photometry of the ball lightning trail was used to measure the brightness H of lightning segments and cross-sections. Cross-sectional H measurements (Fig. 1) show that H

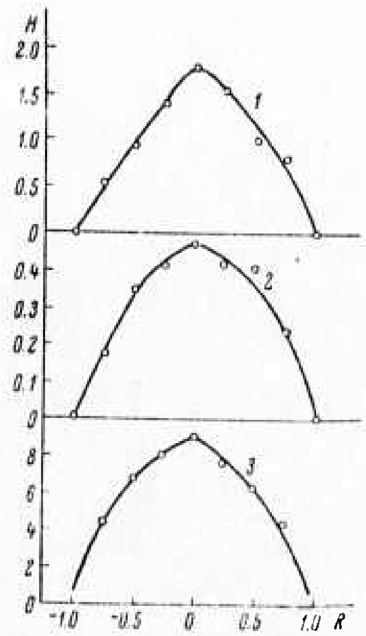

Fig. 1. Brightness H in relative units vs. distance from the lightning center: 1- first, 2- second, and 3- third cross-sections. R = lightning radius.

decreases rapidly as the distance from the center increases, suggesting that emission originates mainly within the lightning volume. Measured H vs. brightness ratios, calculated on the theory of a volumetric emission source, are tabulated for the three cross-sections at varying distances R from the center. The average ratios are 0.99, 0.93, and 0.91 at 0.75 R, 0.50 R, and 0.25 R, respectively. The emission intensity per unit volume is consequently almost independent of the distance from the lightning center. Other possible emission sources are aerosols or other finely dispersed particles The brightness fluctuates significantly along the lightning trail with a maximum at the end of the first segment (Fig. 2). Luminosity faded out

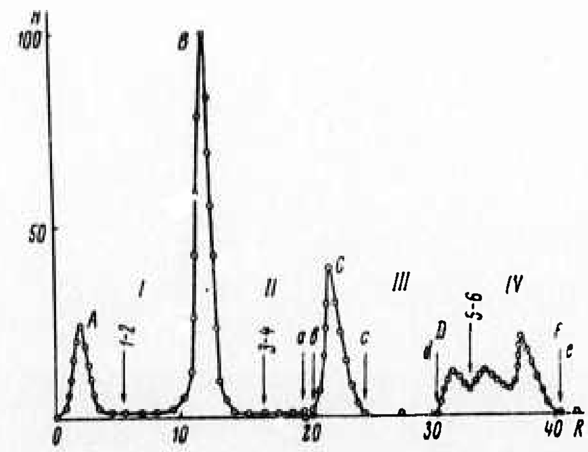

Fig. 2. Brightness H in relative units vs. distance from the lightning origin point. Notation is the same as in Fig. 1. I-IV are the segment numbers, a-b and c-d are the first and second luminosity fade-out, e-final extinction.

at 0.5 R and 3.2 R from the center at the end of the second and in the third segments, respectively. The lightning exposure contrasts are partially explained by the changes of the lightning propagation velocity and brightness.

Aleksandrov, V. V., and O. S. Ryzhov.
Nonlinear acoustics of a radiating gas.
1. Combined analysis of equations. ZhVMMF,
no. 6, 1972, 1489-1511.

The nonlinear propagation is analyzed of disturbances in a gas in which radiation, absorption and dispersion of radiant energy occur. The nonstationary one-dimensional flow of an inert gas is considered, in which energy transfer is accompanied by radiation, absorption and scattering of light quanta. It is assumed that: the gas temperature is not too high, the pressure not too low, the local thermodynamic equilibrium is preserved and the viscosity effects and molecular heat conduction are negligible. Initial equations of gas motion and radiation are derived and it is shown how these equations can be simplified in certain cases. Limiting disturbance propagation regimes are investigated using expansions of unknown functions in series of several independent small parameters. Only the principal terms were taken into account when deriving the asymptotic equations. An asymptotic analysis of the radiation transfer equation was made. Using the radiation energy spectral density function and the transfer equation, it is possible to obtain a very simple form for the derivative $\frac{\partial q}{\partial r}$, where q is the radiation energy spectral flow and r is a coordinate. Depending on the relation between convective and radiative energy flow for waves with finite optical thickness, the quasi-isentropic and quasi-isothermal processes are examined. Equations for these two wave propagation regimes are formulated combining the parameters characterising the state of a gas with those of the radiation field. Media in which the adiabatic and isothermic velocities of sound are almost equal are studied separately. The simplification of initial equations was analyzed using more rigid constraints on the character of light wave propagation. The cases of optical coefficients independent of the frequency (group radiation) and of a gas with a zero scattering factor were also calculated.

Bezuglyy, V. The laser goes underwater. (Laser design for determining plankton concentration). Vodnyy transport, 12 September 1972, p. 4.

The All-Union Scientific Research Institute of Sea Fisheries and Oceanography has tested a laser system of measuring plankton concentration in sea water. The system is based on a laser design used by the Moscow Highway Institute to determine the concentration of particles suspended in turbid media. Sea water temperature measuring equipment, compatible with data processing terminals, is also mentioned, along with a hydroacoustic underwater communication system installed in a bathymetric probe.

Shirokov, V. <u>Cruise to the lunar shadow.</u>
Pravda, 22 May 1973, p. 3, col. 1.

The Soviet research ship Professor Vize is preparing for a two-month cruise which will take it from the North Atlantic to the coast of northern Africa (probably off Mauritania). Vize will carry an expedition headed by Yu. F. Ivanov, Deputy Director of the Institute of Applied Geophsyics to study this century's longest solar eclipse on 30 June. The research program plans involve taking advantage of the fact that the eclipse is only eight days after summer solstice. In the first stage of the program, rockets will be launched from the Vize to study the atmosphere and the mechanism behind the Sun's influence on the upper atmosphere. Some of these launchings will be synchronized with rocket launchings by the Volgograd sounding-rocket station. The synchronous launchings will take place when the Sun is at the same angle to both the Volgograd station and the Vize, which will be positioned somewhere along 49^{o} north latitude (Volgograd's latitude). In this experiment, Soviet scientists expect to obtain interesting upper atmosphere data under identical solar effects on the atmosphere, but under the differing geomagnetic conditions found at the two greatly separated points.

The major portion of the research program will involve scientists from the Institute of Experimental Meteorology, the Central Aerological Observatory, and the Institute of Applied Geophysics, in studying the solar eclipse. Although the eclipse phase will last seven minutes on the continent, the Vize's position provides only a little more than five minutes of coverage. During the five minutes, three rockets will be launched, one of which will be launched at full phase. According to Ivanov, new data on the physics of the upper atmosphere will assist in understanding phenomena which affect weather and the range of radio communications.

Akademiya nauk SSSR. Geologicheskiy institut. Geotermicheskaya karta SSSR v masshtabe 1:5,000,000 (Geothermal map of the USSR in 1:5,000,000 scale). [Moskva], 1972, 4 sheets with explanatory notes (38 p).

The Geological Institute of the USSR Academy of Sciences has published its "Geothermal Map of the USSR (Scale 1:5,000,000). Accompanying this color map is a short brochure outlining the types of field data and methods used in the compilation of the map, basic uniformities in the distribution of the geothermal field throughout the USSR, and some brief conclusions. In addition to the main map (Map of Temperature Distribution on the Surface of the Consolidated Basement; scale 1:5,000,000), the following two inset maps are included:

1) Distribution of Heat Flow in the USSR and Contiguous Countries (Scale 1:30,000,000).

This map shows established and hypothetical heat flow isolines (in 10^{-6} cal/cm^2 sec), and zones comprising the predominating heat flow values are indicated.

2) Distribution of the Geothermal Gradient in the Upper Part of the Earth's Crust (Scale 1:25,000,000).

Established and hypothetical geothermal gradient isolines are plotted, and zones comprising the predominating gradient values, (established and hypothetical) are plotted for: a) areas of platform formation and b) areas of geosynclinal formation. Also shown are areas of salt-dome

tectonics, areas of recent volcanism, and permafrost isopachs for the 0, 100, 300, and 500 meter thicknesses.

The main map illustrates established and hypothetical geoisotherms for the surface of the consolidated basement, as well as isotherms for the thermally "neutral layer" in outcrop areas (from -15° to about +15° C). Established and hypothetical geothermal zones are color-coded in 25° C increments from -25° C to 300° C and above. Fault zones, basement outcrop boundaries, elevations above sea level, thermal springs, and areas of recent volcanism are also depicted.

The total number of points measured and available for the compilation of the maps exceeds 15,000. Of these, 1500 measurements within the USSR were eventually used, with the majority (900 points) falling in the European territory of the USSR. A table is given showing the number of measurements made at 1, 2, 3, and greater than 3 km and distributed over six major regions, two inland seas, and one marginal sea. Noteworthy measurements within the regions and their geological subregions are discussed individually. The major details of the maps (heat flow, geothermal gradient, etc.) are generalized in brief discussions. A second table in the explanatory notes shows the average geoisotherm depth (in 25° C increments from 25 to 300° C) for Precambrian platforms (2) Epipaleozoic plates (3) and intramontane depressions (7).

B. Recent Selections

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Kalyatskiy, I. I., S. S. Pel'tsman, and D. D. Khalilov. On studying the energy characteristics of a pulsed electrical breakdown channel in solid dielectrics. IAN Az, Seriya fiz-tekh i mat. nauk, no. 4, 1972, 117-120.

Khvastunov, M. Lightning against ice (short-circuit deicing of transmission lines). Stroitel'naya gazeta, 25 March 1973, p. 4.

Kitain, V. Ya. Evaluating the impulse response of a radar channel in the presence of additive noise. IN: Tr. Moskovskogo instituta radiotekhniki, elektroniki i avtomatiki, no. 64, 1972, 79-89. (RZhRadiot, 1/73, no. 1G35)

Kuchin, L. F. Generatory millimetrovykh i submillimetrovykh voln (Generators of millimeter and submillimeter waves). Moskva, Izd-vo Znaniye, 1973, 64 p. (LC-VKP)

9. AUTHOR INDEX